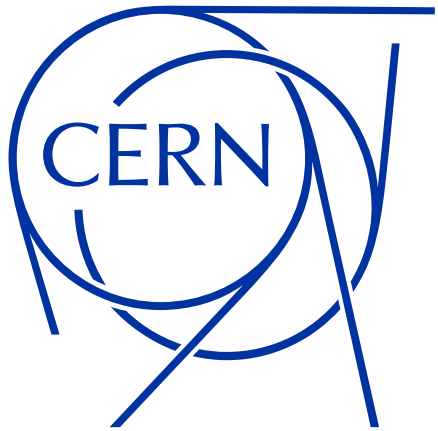




Future Perspectives of the AD-ELENA Facility at CERN

D. Gamba, F. Butin, L. Ponce

ACKNOWLEDGEMENT: D. Aguglia, C. Amsler, M.E. Angoletta, W. Bartmann, R. Billen, J. Borburgh, J. Bremer, M. Calviani, R. Caravita, C. Carli, Y. Dutheil, S. J. Freeman, S. Gilardoni, J. Hangst, W. Hofle, M. Hori, L. Joergensen, R. Jones, T. Lefevre, B. Lefort, O. Marquversen, A. Newborough, D. Nisbet, A. Obertelli, Y. Papaphilippou, P. Perez, G. Petrika, A. Sinturel, T. Todorovic, S. Ulmer, C. Vendeuvre, M. Wehrle... .. and many more colleagues!!

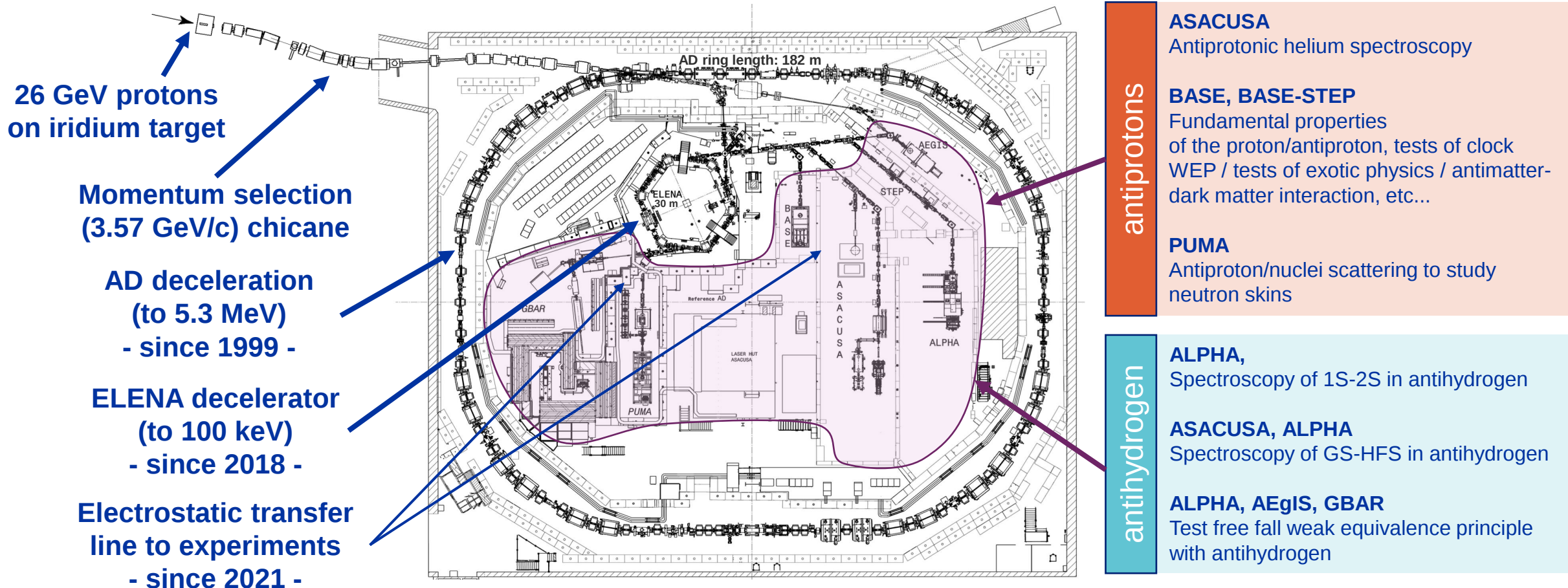
26/08/2024 – International Conference on Exotic Atoms And Related Topics and Conference on Low Energy Antiprotons ([EXA/LEAP2024](#))

Outline

- **Today's AD/ELENA Facility**
 - What it is and how it works
 - **Current Beam Performance**
 - Extrapolation toward possible short time-scale improvements
 - **Possible Paths for Extending the Physics Reach of the Facility**
 - Engaging in forward-thinking to match possible future experimental requirements with (minor) changes
 - **DISCLAIMER 1: based on informal discussions only!**
 - **Wrapping up and Conclusions**
- **DISCLAIMER 2: most slides based on recent talks at Chamonix 2024, PBC 2024, FuPhy2024 workshops. No commitments from CERN for any study/upgrade of AD/ELENA at this stage!**
- => We are looking for YOUR INPUTS and REQUESTS!**

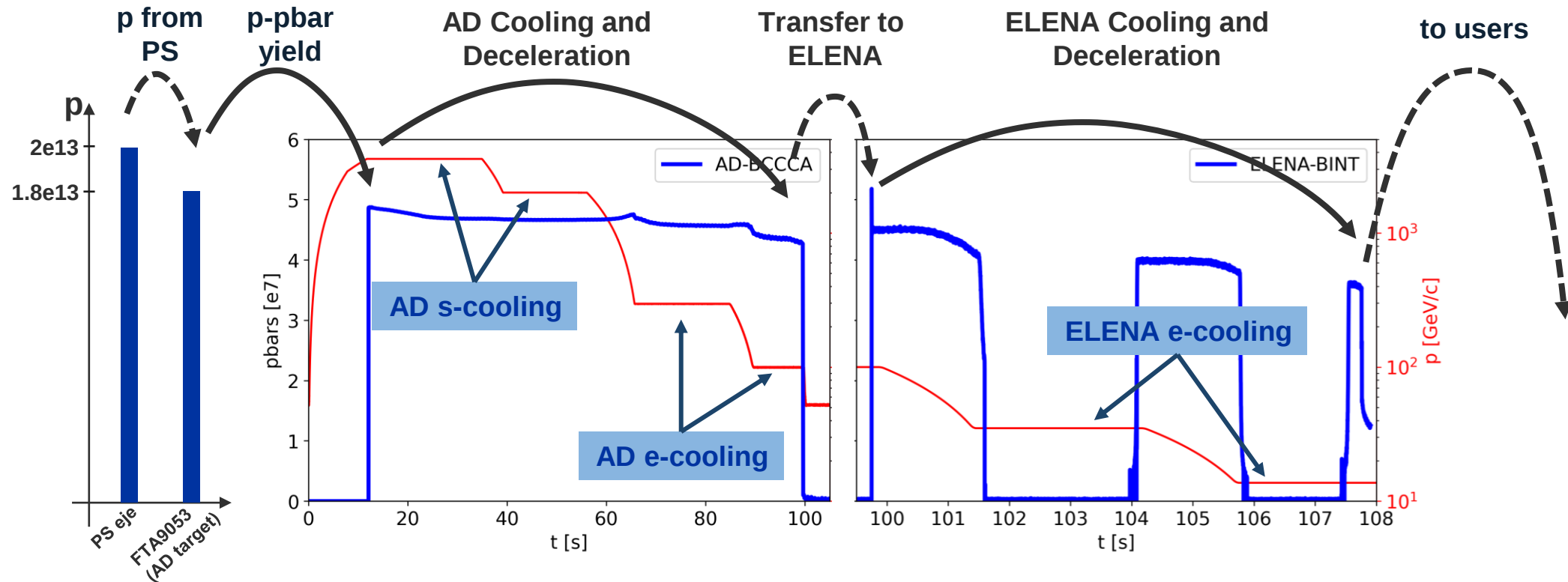
AD/ELENA: a Unique pbar Facility!

- The **only place in the world** with **low energy pbars** in a synchrotron!
 - It seems unlikely to have similar capabilities elsewhere for the next 10-20 years
- **Serving 60 Research Institutes/Universities – 350 Scientists – 6 Active Collaborations**



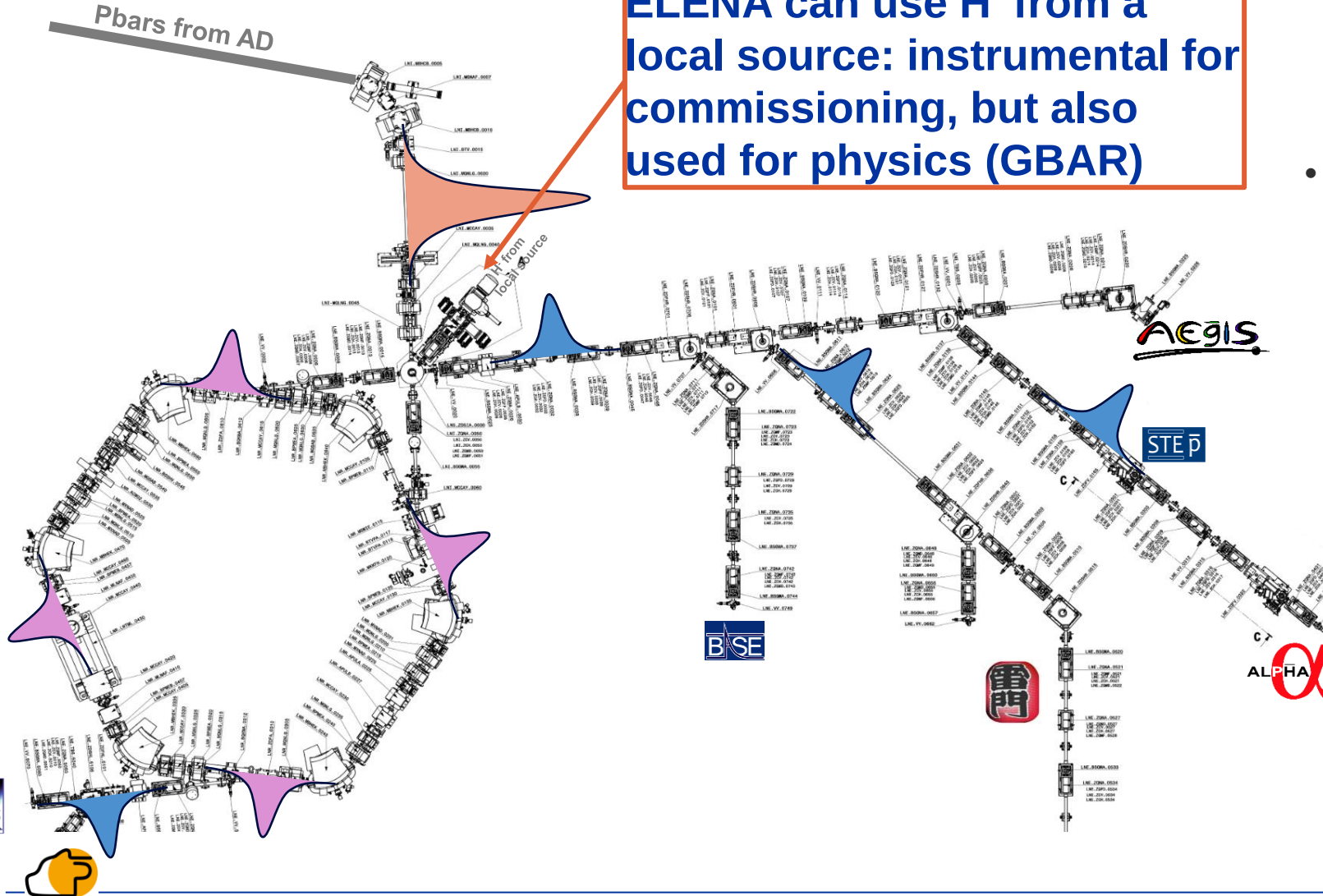
From 25 GeV p to 100 keV pbar: 4e7 pbars/2'

- Generating pbars from 26 GeV/c protons (yield of the order of 3e-6 pbar/p)
- Up to **80% deceleration efficiency** from **2.75 GeV** (3.57 GeV/c) to **100 keV** (13.7 MeV/c)
 - Requiring several stochastic and electron cooling steps

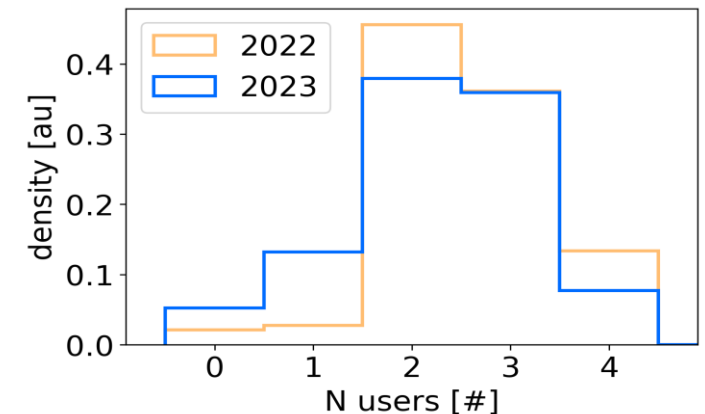


Serving 4 Users at a Time

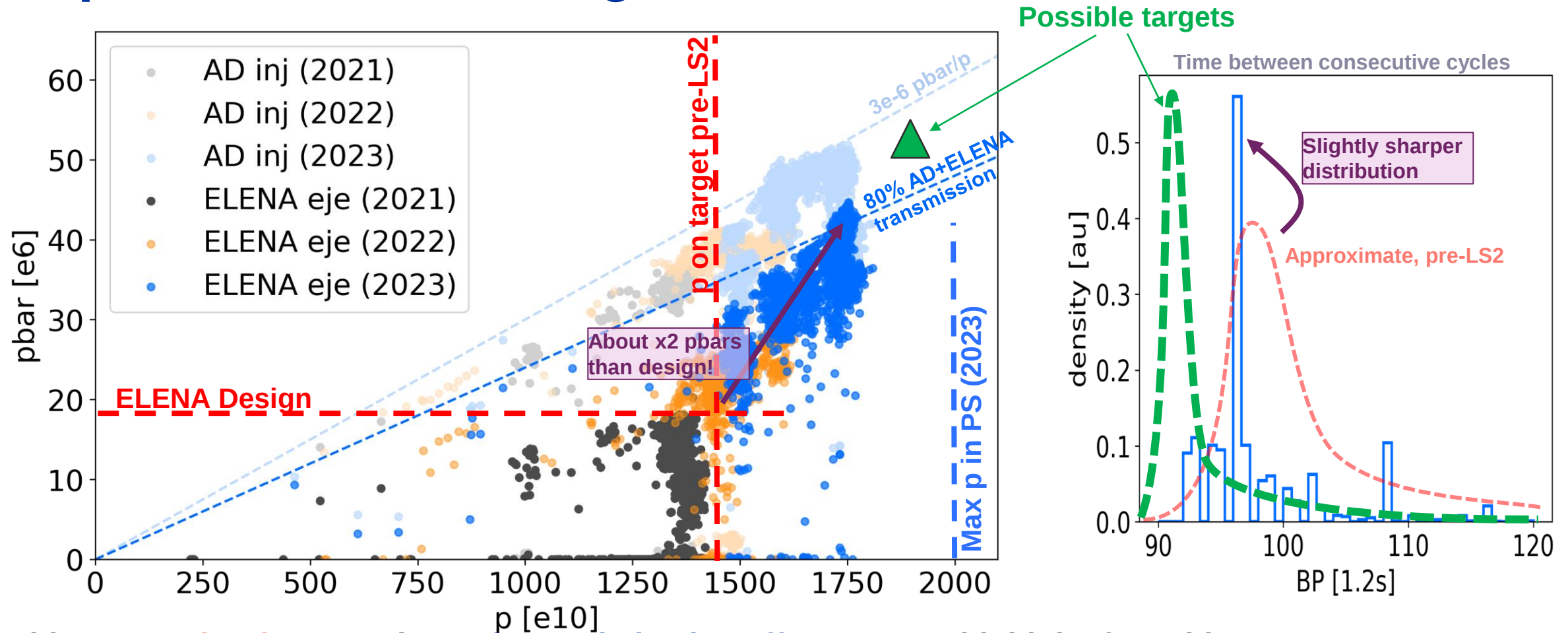
ELENA can use H^- from a local source: instrumental for commissioning, but also used for physics (GBAR)



- AD produces 1 bunch at 5.3 MeV
- ELENA: 4 bunches at 100 keV
 - <150 ns FWHM
 - <1e-3 RMS dp/p
 - <4 μm emittances (<3 μm in 2024)
- Up to 4 experiments served at the same time with $1e7$ pbars/bunch
- 24/7 beam availability was the key game changer for AD users!
- ~30% of bunches “wasted”, but comfortable for (most) experiments in present “ELENA R&D” phase...



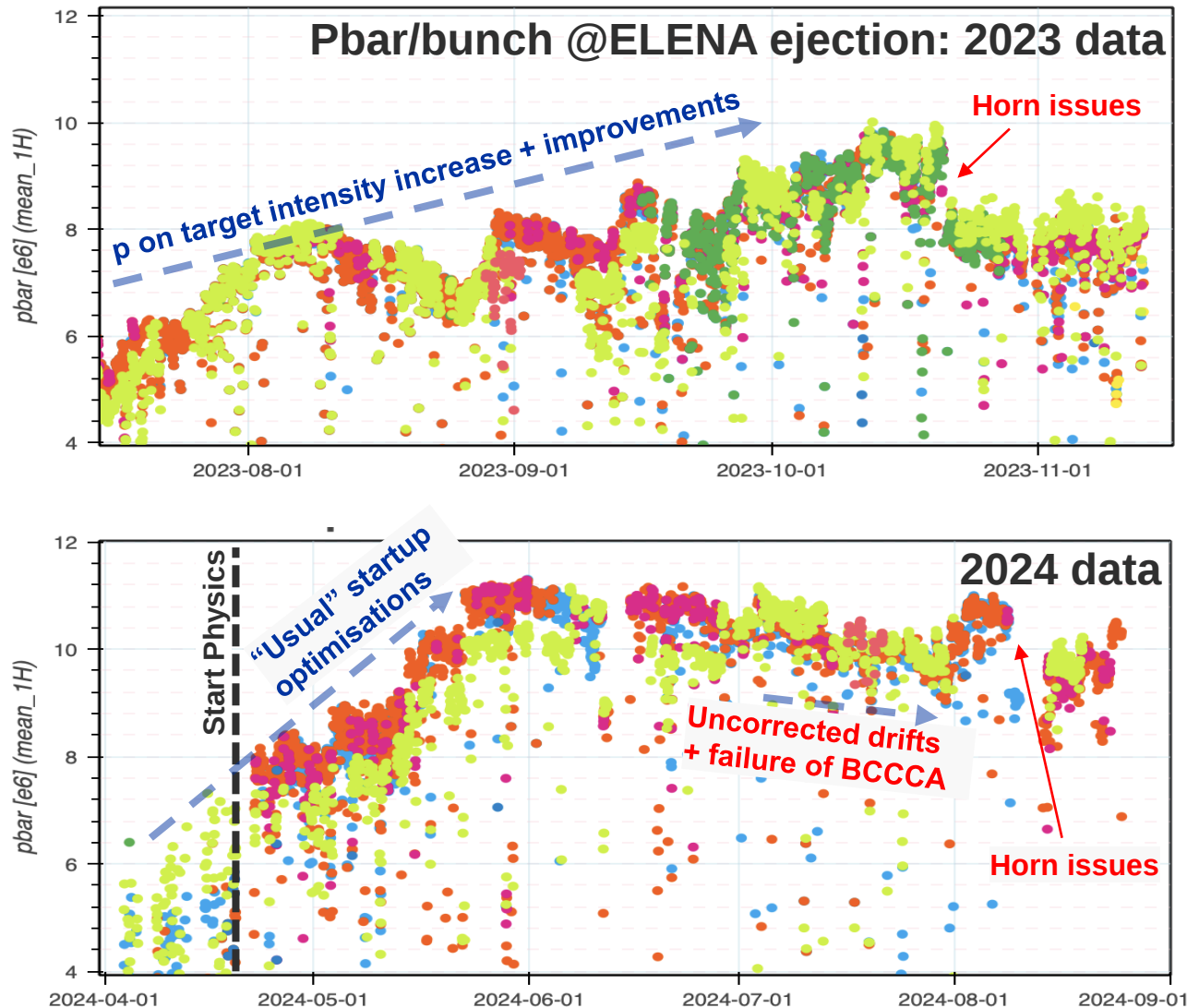
x2 pbar Flux than Design



With **present hardware** and **ongoing optimisation efforts** we could think of reaching:

- **10-20% increase in beam intensity** (**stability to be improved** with consolidated hardware/instrumentation)
- **10-20% reduction in cycle length** (stability mainly linked to p production scheduling)

Quick Status of the 2024 vs 2023 Run



- For 2024, no major performance increase were expected, but:
 - Back to operational horn and maximum proton intensity: expected to go **back to 2023 peak performance** of $1e7$ pbar/bunch extracted from ELENA
 - New working point in ELENA: **emittance reduction** for experiments
- Overall, **smooth restart** and **excellent performance** quickly obtained
- “Usual”(?) **critical items** on the way:
 - Failure of AD BCCCA
 - Partially blind operation in AD
 - Issues with AD Target **Horn**
 - Downtime and lower pbar yield

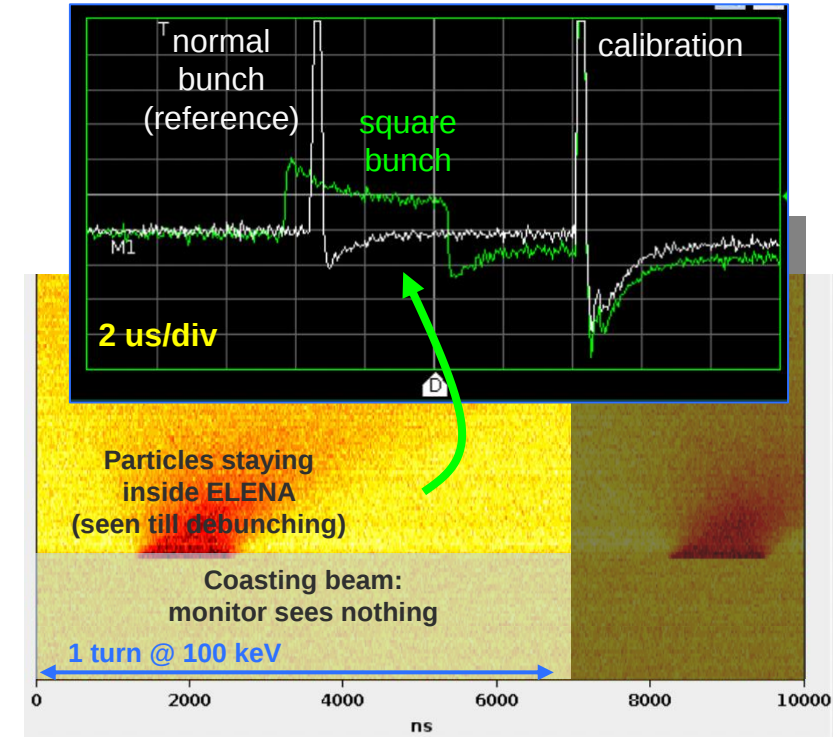
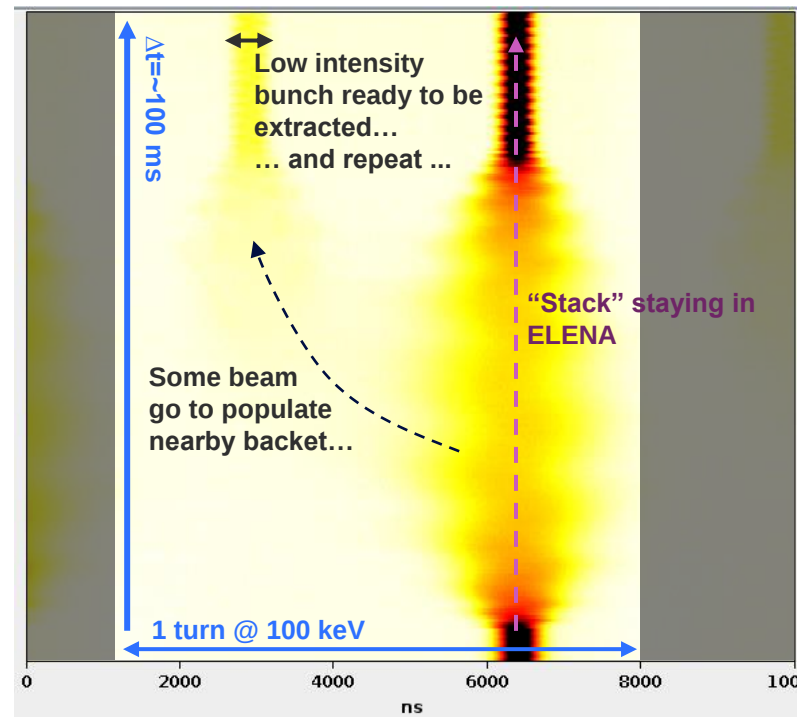
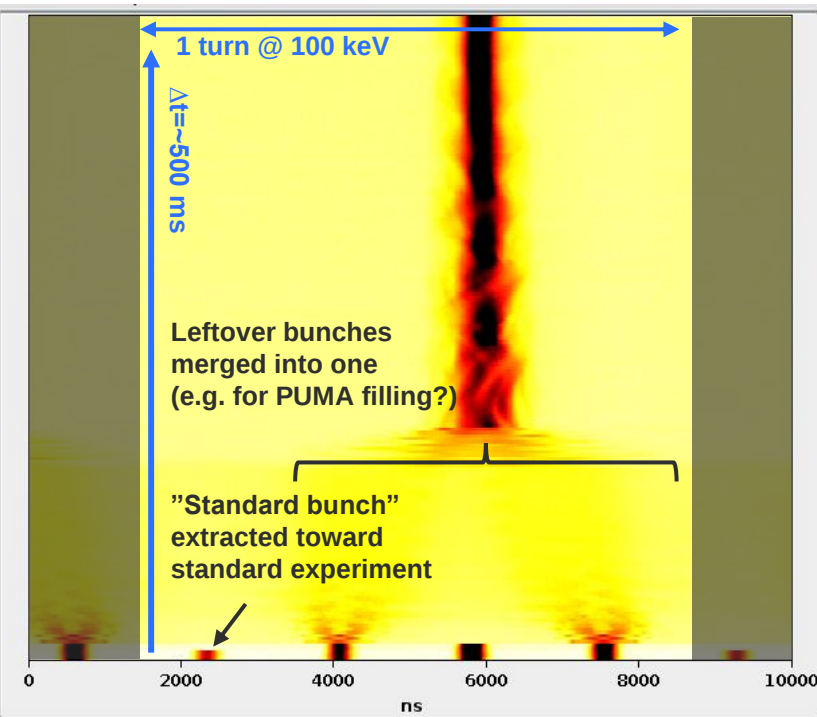
⇒ **the highest integrated # pbars ever!**

Happy Users with Ambitious Goals

- **Present users are happy !**
 - **No strong request for “better” or “more” beam:** still exploring the potential of ELENA!
 - **Desire** for higher **shot-to-shot repeatability, beam availability** and **continuity**
 - Investment in **modern technologies/techniques** **crucial** for enhanced **beam stability** and **efficient operation** (this includes optics, control, instrumentation, ...)
 - **Paramount** to finalise/pursue **AD consolidation** efforts
 - **This is an opportunity for AD-related upgrades !**
 - Must ensure a **long term pbar-facility lifespan** (20+ years)
- **Technological challenges are after the handover point !**
 - **No clear direction** for new/future (beam) requirements from AD/ELENA
 - **Can we anticipate (your) future user wishes ?!**
 - **Note: time for triggering upgrade studies (to be ready for LS4) is now !**

Short-Term Opportunities Leveraging on ELENA

- ELENA still has some un-explored potential at extraction
 - E.g.: producing 1-to-5 bunches (instead of today's 4), or other "exotic" configurations, e.g.:



- Mostly requiring some minor modifications, new logic, tests, ...
 - **Not readily available today: need some formal request, if users (you) require their implementation**

TELMAX: a new Test Area for new Ideas and Users

- Refurbishment of the old ATRAP2 area and conversion into a **TEST Line for Machine And eXperiments**:
 - For accelerator equipment tests (e.g. instrumentation)
 - For **experimental equipment characterization** (e.g. foils, detectors R&D/calibration)
 - ...
- The area reorganized to increase usable surface :
 - **Standard services** will be provided (electricity plugs, demineralized water, compressed air, etc....)
 - **Changes** described in the ECR: **EDMS [2975107](#)**
 - **Normally available by end of 2024 !**
- **Beam-time request strategy being formalized**
 - will normally be regulated by “standard” **SPSC Beam Time Requests** as for other facilities
 - **Start expressing your interest now ! e.g. to [B. Holzer](#) or [F. Butin](#)**



A First Potential User for TELMAX: PAX

- Short-term nuclear physics experiment (different community than today’s users)
- R&D experiment to test detectors (and possibility for new high precision QED studies)
- Requiring something close to “slow extraction” at 100 keV

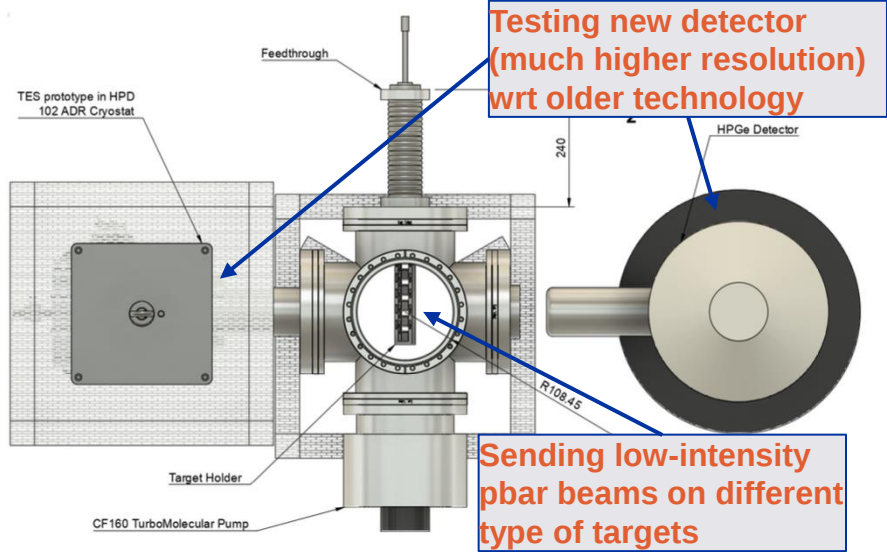
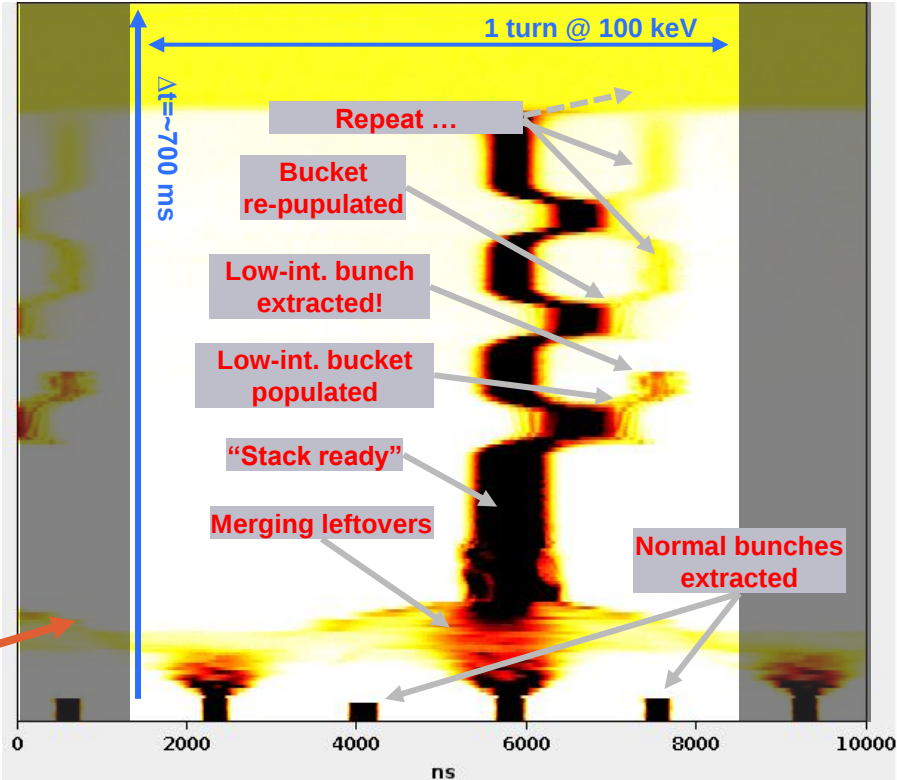


TABLE 2 Three possible ELENA beam configurations that are compatible with the PAX test beam physics goals, organized in order of preference. The physics settings refer to those indicated in Table 1.

Beam structure	pbars / bunch	number bunches / AD cycle	physics settings	time
Multi-bunch	$10^4 - 10^6$	20	1-3	3 weeks
Multi-bunch	$10^4 - 10^6$	20	1	7 days
Single bunch	10^5	1	1	3 weeks



- A possible implementation:**
1. Deliver bunches as usual
 2. Merge remaining beam
 3. Repeatedly populate a “nearby” bucket and extract

If one is allowed to dream...
... looking Beyond the Horizon

Higher Intensity? e.g x2?

- Already at 80% **AD+ELENA** deceleration efficiency, i.e. up to **20% gain at very most**
- Already at the maximum **p intensity** in the PS:
 - **10% to gain at very most** on PS-to-AD proton transport efficiency
 - Present **target design already at engineering limits** and **radiation levels** close to **limits!**
- **Directly increasing the pbar yield (new AD target/horn design?)**
 - **No obvious recipe:** lengthy and complex studies requiring dedicated beamtime

One way could be **accumulation at AD injection**

- Tested during early AD times (see [CERN-ACC-Note-2019-0025](#))
- Possible to reach more than **x2 in intensity** (optimistically, up to x10), but **it requires dedicated studies**

Note 1: We might be limited by **radiation levels in the AD hall**

Note 2: **bunch properties** at ELENA extraction will be **affected** (higher emittance, length, ...)

Note 3: Accumulation in traps? Your business: probably easier, but also **less efficient on flux...**

Higher Rep. Rate? e.g. x2?

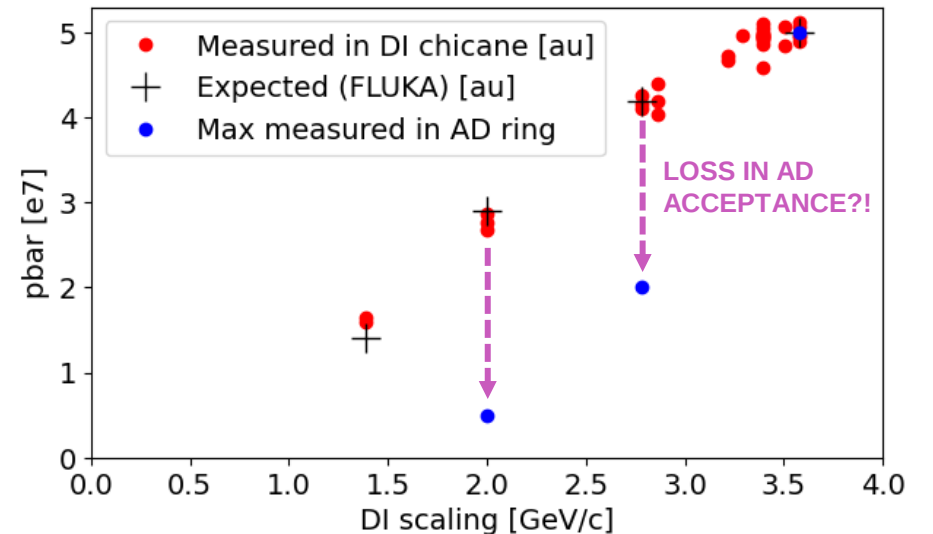
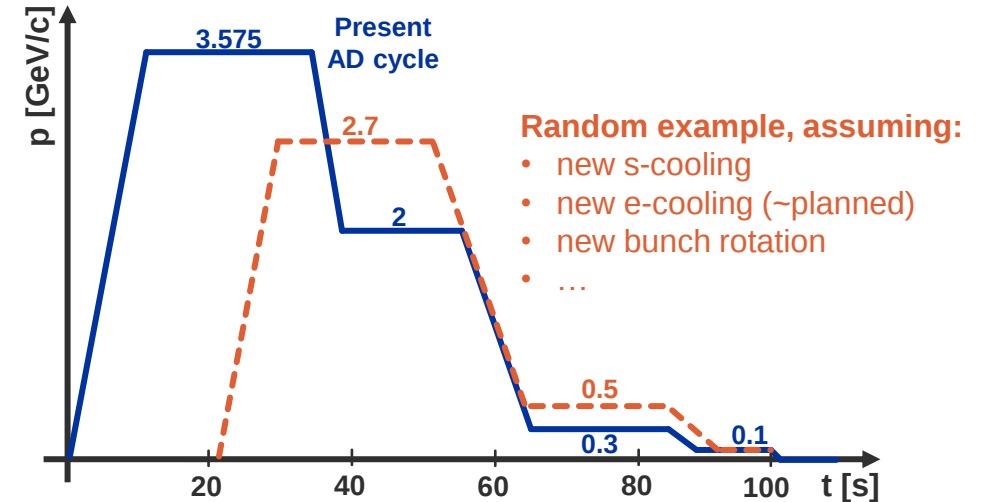
- **Cycle length driven by cooling processes in AD (~50%)**
 - New AD **e-cooler** designed to hopefully gain **10%** on cycle time
 - Maybe possible to save **10%** on cycle time with an “improved” **s-cooling**?
 - Maybe trying **injecting in AD at a lower momentum**?
- **Additional inefficiencies from beam control**
 - Maybe possible to save **10%** on cycle time with “improved” **power converters**?
 - Maybe possible to save **10%** on cycle time with better **beam instrumentation/controls**?
- **Overall, maybe possible to gain a factor 2, at most** (from 110 to 60 s cycle time)
 - **Investment on hardware/studies needed, if requested!**

Note 1: We might be limited by **radiation levels in the AD hall**

Note 2: It requires also higher use of **proton cycles**!

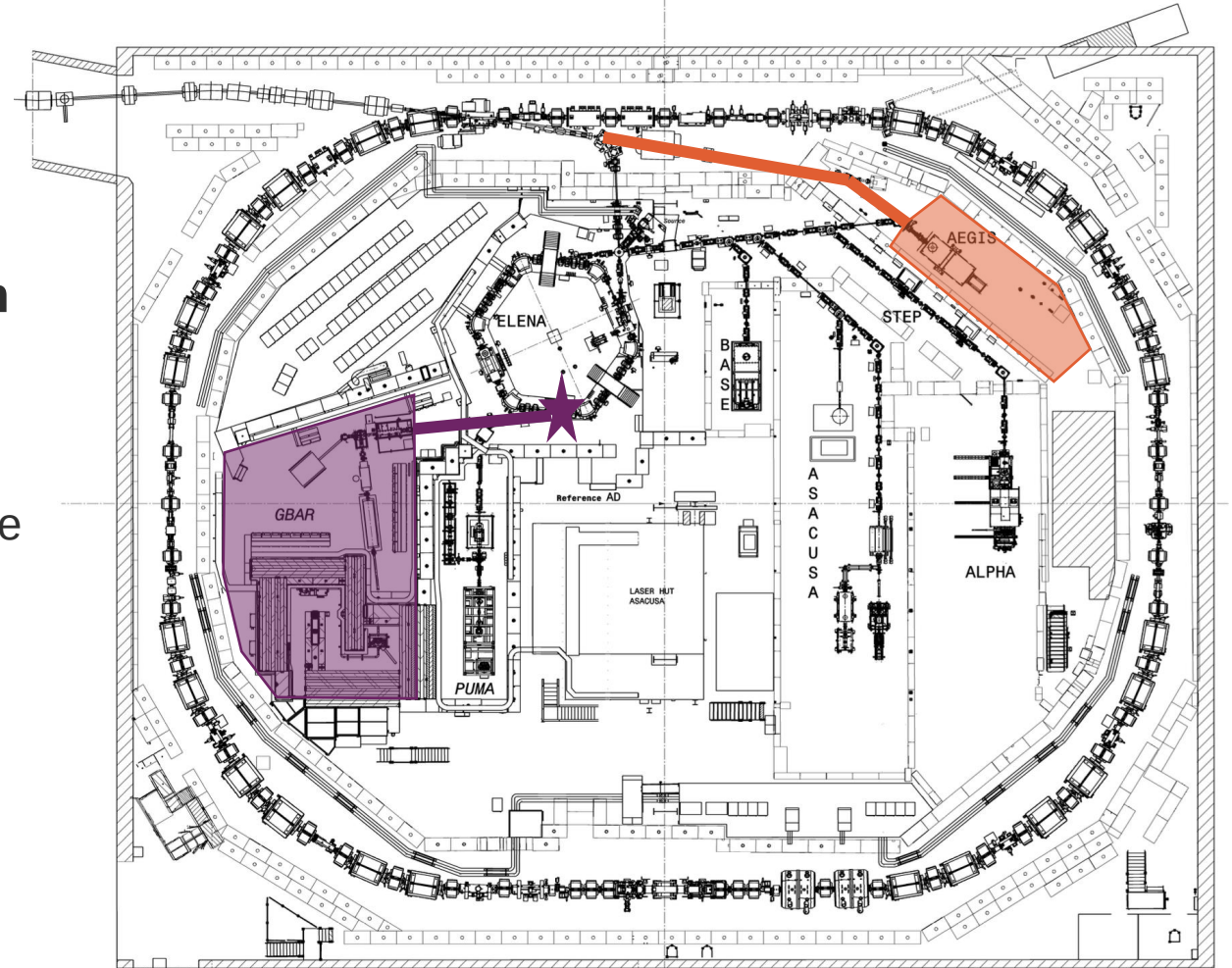
Simpler/Shorter AD cycle for Fixed pbar Flux?

- 3.575 GeV/c was chosen to optimize accumulation at AA/AC times
- A new AD-like machine could be optimized differently with fix pbar flux, e.g.:
 - minimise energy use
 - simplify the cycle structure
 - ...
- **Significant impacts** on s-cooling, bunch-rotation, and RF systems.
 - However, it's a good opportunity to **profit of anyway necessary consolidations**
- Ongoing tests useful for:
 - Benchmarking AD target FLUKA models
 - Potential antideuteron search



Different Extraction Energy? e.g. 100 MeV - 50 keV?

- **Note:** RP aspects to be evaluated!
- Considering reviving **AD** extraction up to 500 MeV/c ($\sim 125 \text{ MeV } E_k$) to, e.g., AEGIS zone
 - It **might require exclusive beam use**, limiting ELENA's multi-user capacity
- **Could be studied, if requested!**
- **Extraction up to 100 MeV/c ($5.3 \text{ MeV } E_k$) from ELENA?**
 - Requires to install a **more powerful extraction kicker + septum** (as the injection one)
 - **Adaptation or redesign of transfer line(s)** will be required, potentially using new magnets
- **Could be studied, if requested!**
- **Lower energy possible down to $\sim 85 \text{ keV}$**
 - but **never tested in operation!**
 - **below ($\sim 50 \text{ keV}$?) could be studied, if requested!**



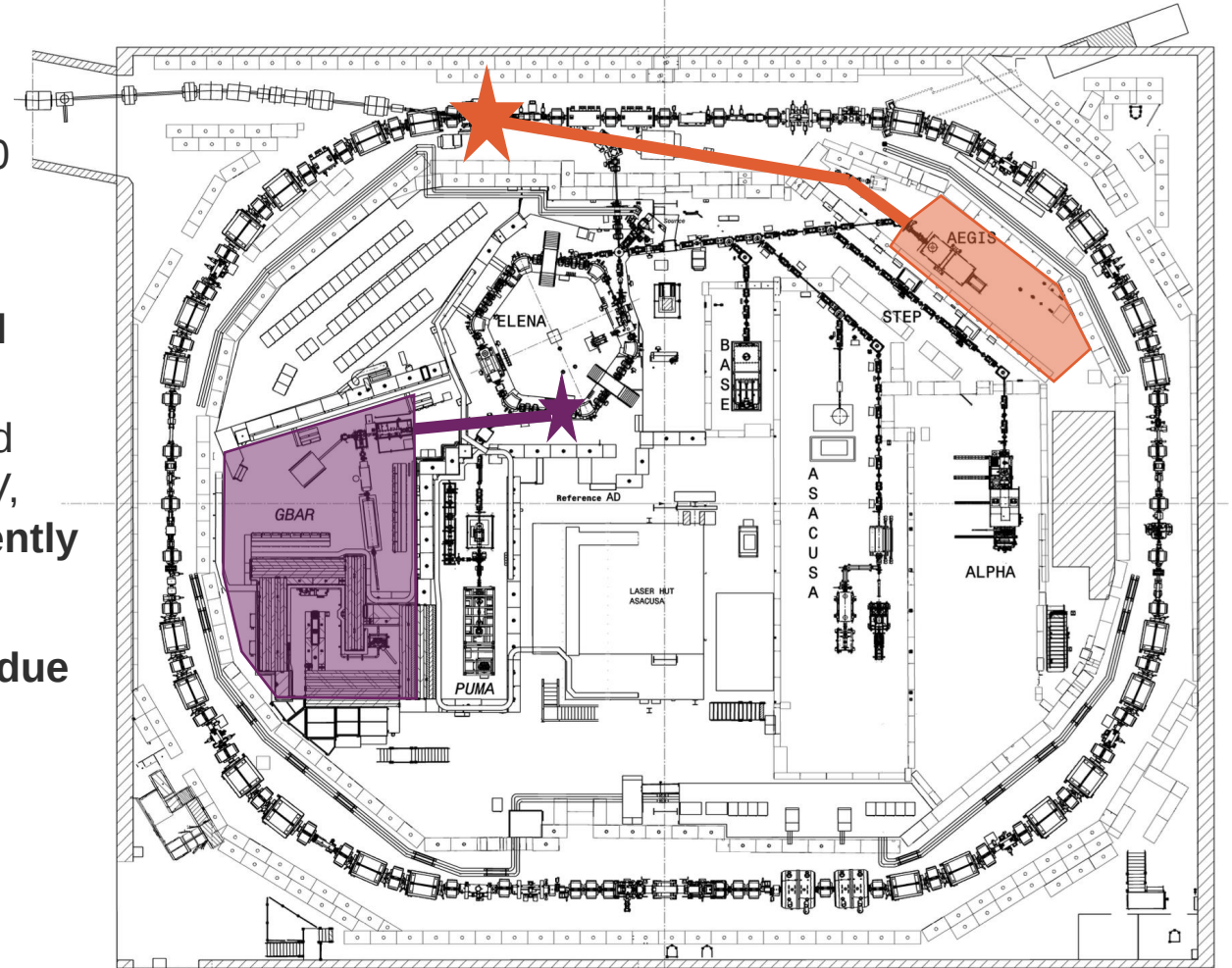
Slow Extraction from ELENA and/or AD?

Courtesy Y. Dutheil et al. – CERN SY-ABT

- **Note:** In concert with experiment requests at the time, the **ELENA** ring **wasn't designed for slow extraction** and **no studies** were done for this
- Presently bunched beam is fast extracted
 - 500 mm long device with 400 mm plates provides ~ 40 kV.m integrated field to achieve 220 mrad deflection
- **Resonant slow extraction from ELENA** with an electrostatic septum blade to provide continuous spill from ~ 100 ms to $\gg 1$ s **might be possible**
 - Drop-in replacement of present extraction device could reach extraction **up to 450 keV** with a voltage of 10 kV, although **transport** to an experimental area is presently **limited to ~ 100 keV**
- Slow extraction **from the AD ring may be challenging** due to higher energy and limited space on the ring lattice

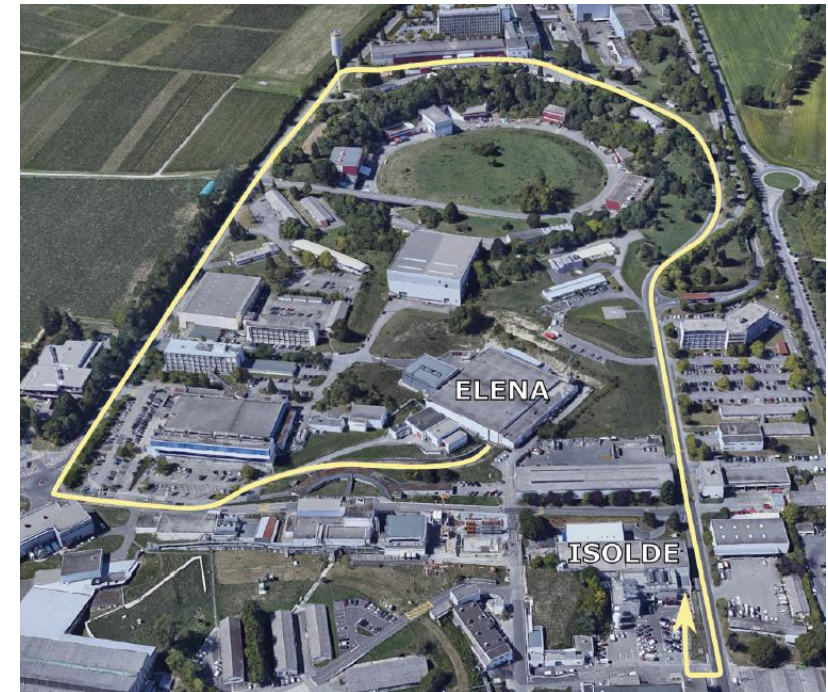
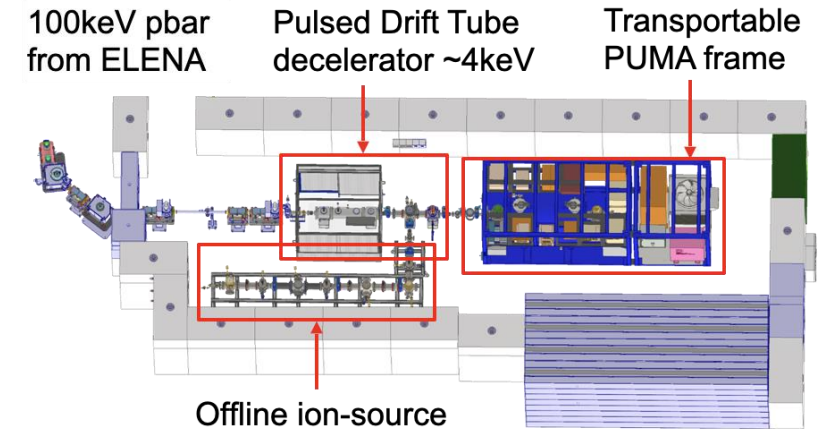
Note 1: Activities need to reach CERN approval before significant resources can be allocated!

Note 2: Already done/planned within experiments at very low energy (a few 100 eV) ...



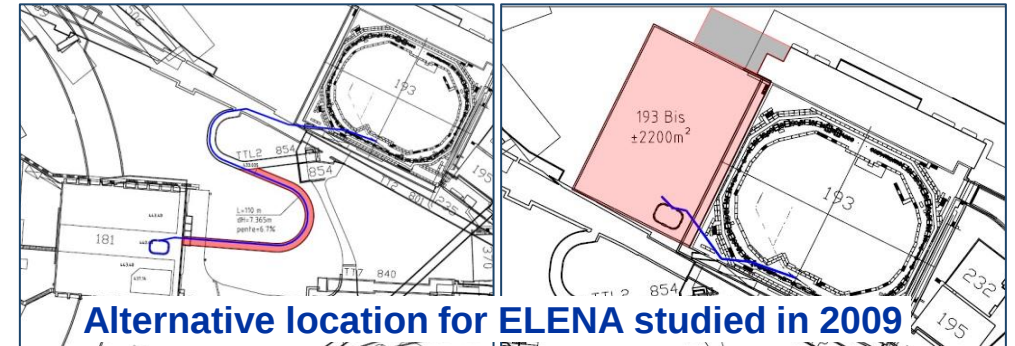
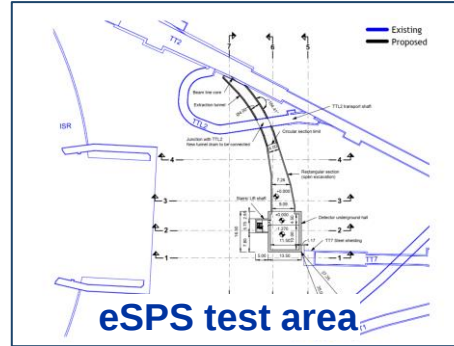
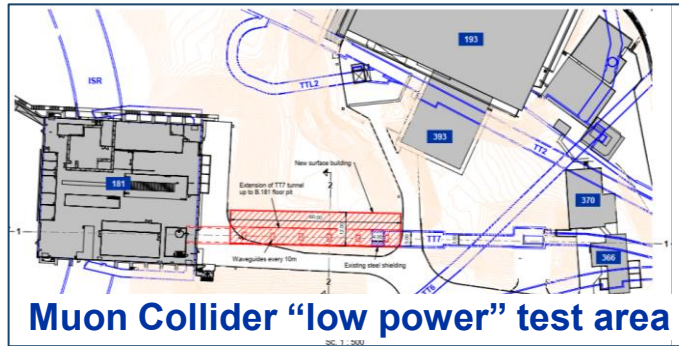
More Off-Site Traps? e.g. a common portable trap?

- PUMA and STEP plan to fill a trap that will allow to **transport cold pbars to other facilities** (e.g. to ISOLDE for PUMA)
 - **Several challenges to be demonstrated!**
 - For STEP, the main reason is to “**escape**” the AD hall’s **electromagnetically noisy environment**
 - **First results** should come soon!
- Will this open **new experimental possibilities?**
 - Shall CERN acquire trap technology and provide “standard” pbar-filled “bottles” for users?
 - **Discarded in the past:** too different user needs... will the PUMA/STEP experience change the picture?
 - **Maybe interested users could produce a “common” proposal for a general-purpose trap?**

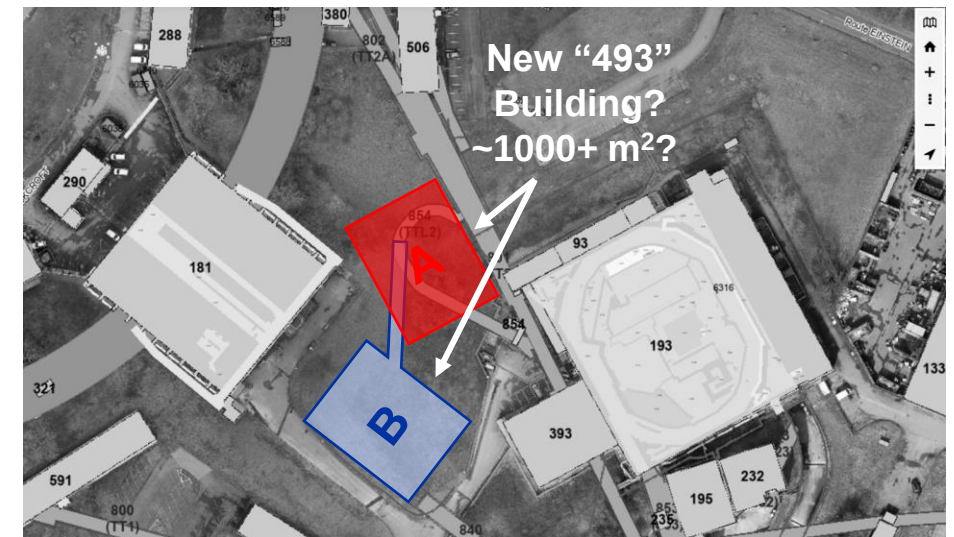


Bigger Exp. Area? e.g. 1000m² more?

- One must be looking outside of the AD hall, looking at other projects:



- TTL2 is empty and **not useful**, today.
 - What about **new building** (493?) with semi-underground experimental area for "high energy" experiments?
 - It could take **protons** from PS, **pbars** (up to 3.5 GeV/c?) from AD, **e⁻** from **eSPS**?, used as **Muon Collider** "low power" test area? (e.g. A, B, ...)...
 - **Could be studied, if requested !**

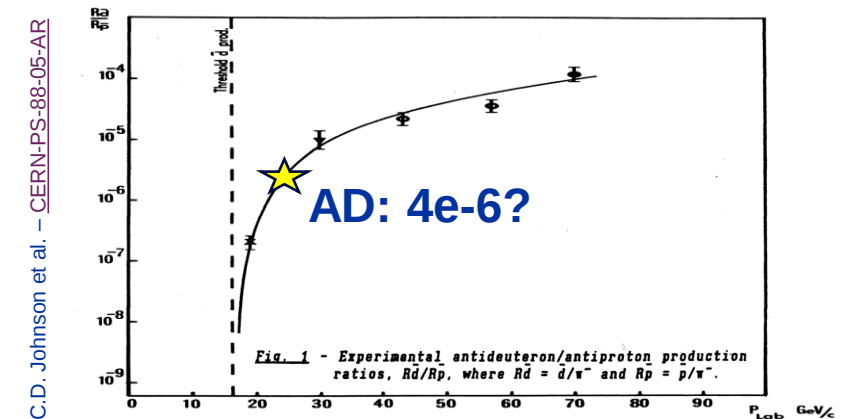
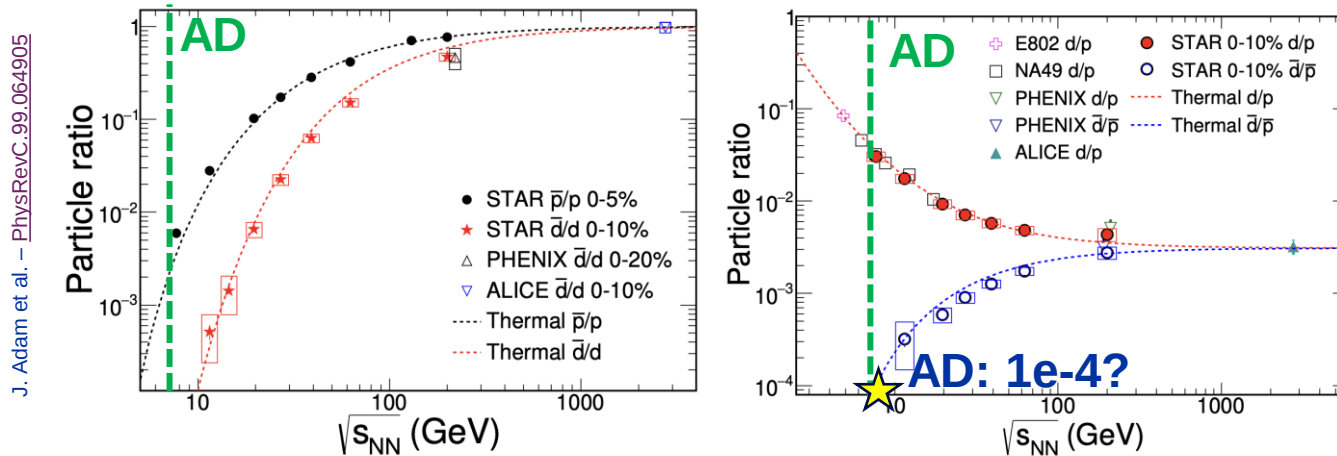


New Particle types?

- **In the experiments** (your core business)
 - **Anti-Hydrogen molecule**
 - Might benefit from **higher pbar intensity/shot** ?!
 - **Antiprotonic atoms** (see AEGIS, ASACUSA, ...)
 - E.g. production of S(uuddss) hexaquark (dark matter candidate) from pbar - ^3He reaction in a trap
 - Might benefit from **higher pbar flux** (intensity or rep-rate) ?!
 - **Anti-Neutrons**
 - Typically, requires **slow extraction at high energy** (>100 MeV/c) on a target
- ⇒ **Present AD/ELENA pbar flux is assumed to be good enough for those experiments**
- ⇒ i.e. **no need for upgrades** (but **slow extraction** at high momenta for anti-neutrons...)
- ⇒ **Is there a most likely upgrade, but slow-extraction in AD, for the AD/ELENA that would result in some breakthrough?**

What about Antideuteron?

- Maybe possible to have ~10 to ~1000 antideuteron at AD injection already today ?!



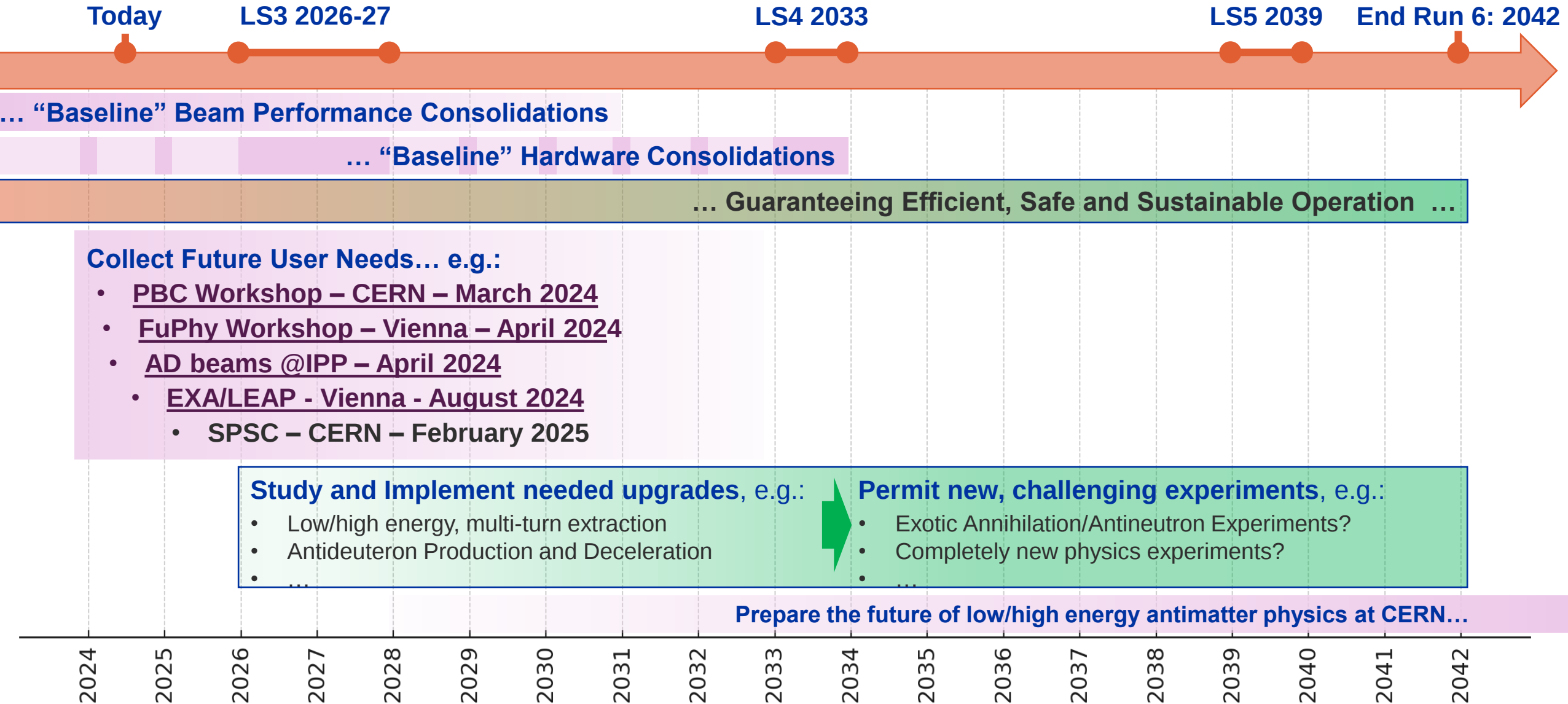
- So far, **not possible/being able to detect antideuteron in AD ...**
 - Informally exploring the feasibility of a **single-particle Resonant Schottky detector** in AD ...
 - Still, assuming they could be decelerated/trapped, **would those numbers be interesting?**
 - **Note:** even if $\bar{d}$ found, **s-cooling** and **RF systems** will require **key modifications to allow deceleration!**
- **A new target and/or full facility might be required:**
 - A question that would **need to be addressed to relevant strategic bodies beyond AD/ELENA ...**

Overview of “Independent” Upgrade Cases

- Any of these (except TELMAX) will require well-defined physics experiment cases!
- The actual cost and feasibility of each option will be evaluated if and when required.



Overall Long-Term Timeline Proposal

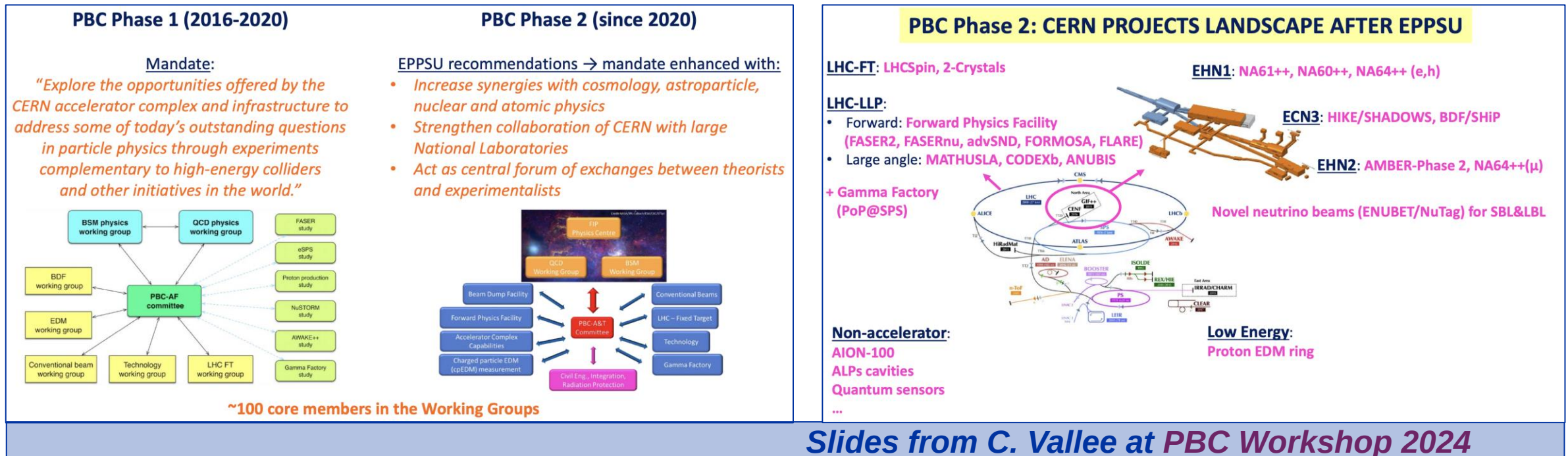


Taking Action: Your Proposals are Awaited !

- CERN SPSC – **11-12 February 2025** - [link](#)
 - SPSC (might be) expecting **long-term** (beyond LS3 and, possibly, LS4) proposals
- **European Strategy Update - 2026** - [link](#)
 - Could be the place where to submit even **longer term** or “**new facilities**” (e.g. **antideuteron** at CERN, **high(er)-energy-related pbars physics**, ...)
 - Written **inputs** expected **by 31 March 2025**
- **Note : major upgrades normally take place during Long Shutdowns :**
 - **LS3 (~2026-2028 for injectors)**
 - **Already too late** to propose **major upgrades** for AD/ELENA
 - **Maybe possible** to push for minor upgrades, e.g. **slow extraction from ELENA** at 100 keV ?
 - **LS4 (~2033 for injectors)**
 - **Major consolidations** already expected (e.g. **power supplies**), **if facility approved beyond LS4 ...**
 - “**Last**” chance for **major hardware upgrades of AD/ELENA**
 - (I suppose concrete **requests**, at least **for studies**, must be made **by end of ~2025**)

PBC Study Group: Your Primary Point of Contact for Support

- CERN has put in place the Physics Beyond Collider Study Group in 2016 to support studies for new experiment/proposals at CERN
 - see for example [ECFA2022](#) and [PBC2024](#) and [PBC official website](#)
- (to my knowledge) no AD/ELENA experiment is presently profiting of this programme
 - **It is the natural interlocutor to assess and possibly fund feasibility studies for new experiments!**



Slides from C. Vallee at [PBC Workshop 2024](#)

Conclusions

- **AD/ELENA Facility is a unique facility worldwide**
 - Unique globally, with no realistic alternative for the next 20+ years.
 - Consistently delivers $4e7$ antiprotons at 100 keV bi-minute to six thriving collaborations
- **Short-term Prospects**
 - No pressing demand for “more antiprotons”, today
 - Potential for minor **performance improvements** (+10-20% intensity and repetition rate)
 - We can still **take advantage of some flexibility in ELENA** (e.g. number of bunches/extractions)
 - Establish the **TELMAX** Beam test area to boost component development and **support new/old users**
 - Slow extraction from ELENA@100keV **might be feasible**, but **not formally requested, yet**
- **Long-term Prospects**
 - Extend facility's physics reach is **possible**, depending on emerging cases
 - **Proposals/requests must come “now”** (e.g. SPSC 2025, European Strategy Upgrade), ...
 - **Hardware consolidation** within AD presents new use case **opportunities**
 - **PBC is an asset** framework to intercept and actualize new requests (e.g. **support feasibility studies**)

Looking forward to new, exciting, yet realistic, user requests to trigger relevant studies!

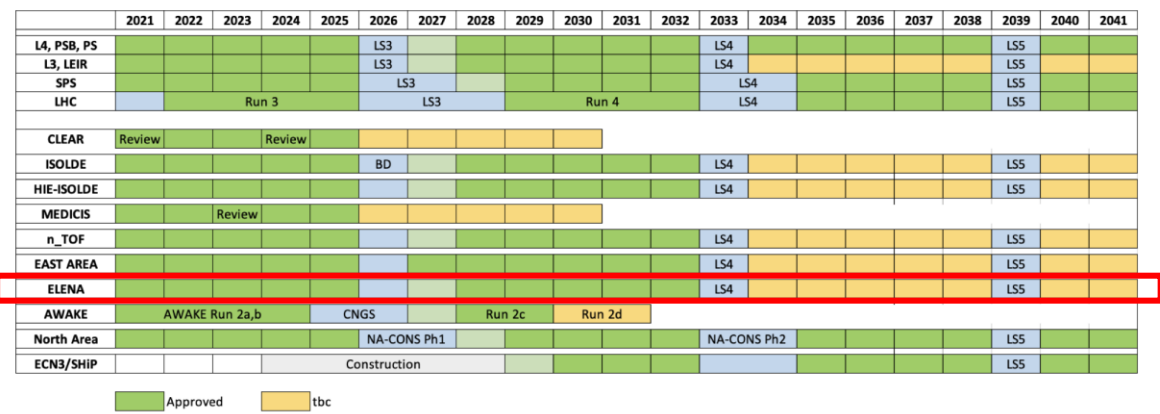
APPENDIX

Some Important Updates

- 1. ELENA (and so AD) are approved facilities at least until LS4. Future “tbc”...
 - Same situation as other “Beyond Collider” facilities at CERN
- 2. There is high probability that LS3 will be delayed by at least 6 months!
 - Possibly, some more time for machine tests to think about AD/ELENA improvements...

Mike Lamont – June 2024

Facilities - outlook



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Mike Lamont – June 2024

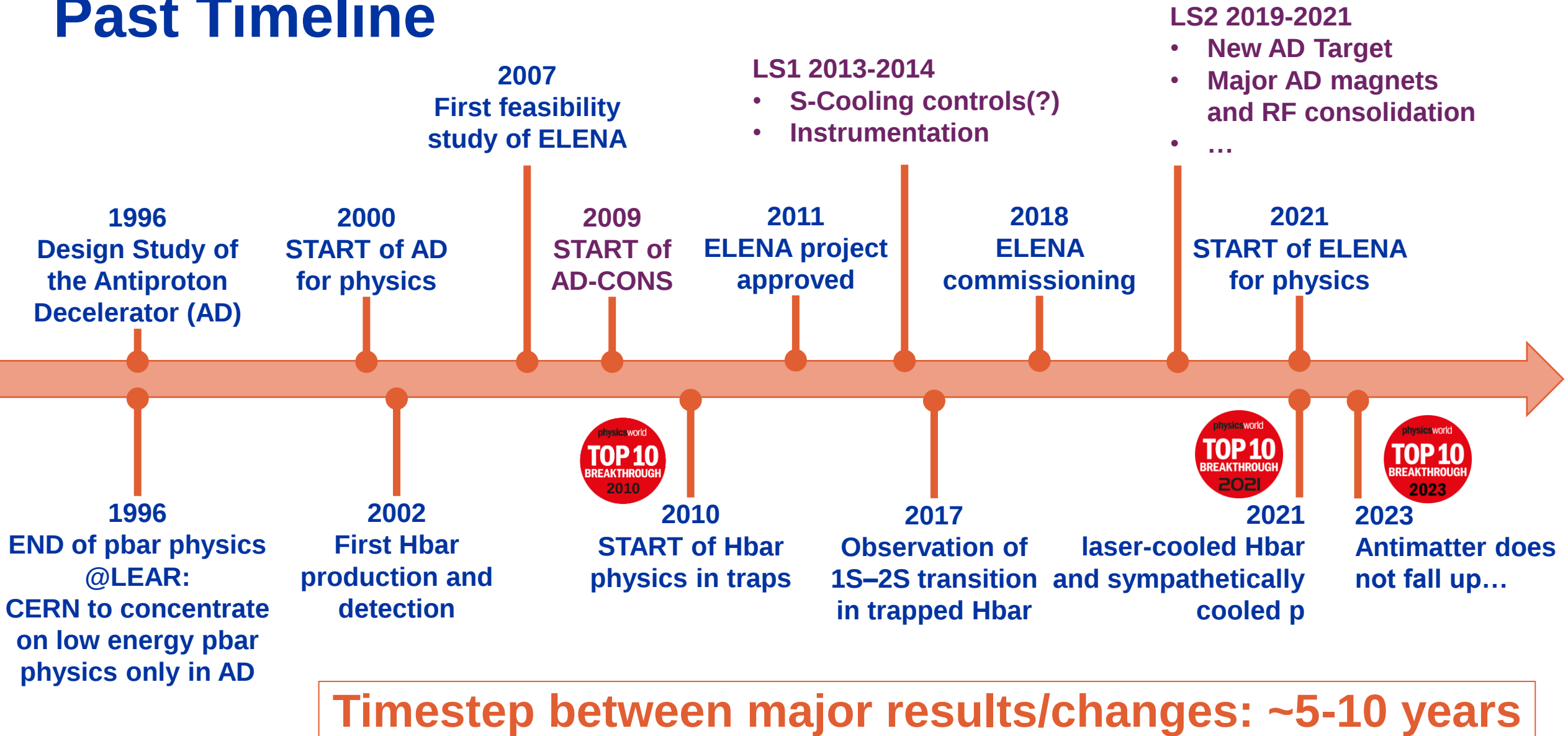
Phase II Risk Assessment: ATLAS

Decision before LS3 Readiness
Review 11-13 September

ATLAS most significant risks:
Please note: risks generally affect parallel activities ⇒ their impacts should not be added

	Risk	Probability (%)	Impact (months)	Mitigation // Response	Cost - Material (kCHF)	Cost - Personnel (kCHF)
ITk Strip	Technical issues with custom connectors/cables being procured from industrial partners leading to delay of harnessing contracts	10	6	Contracts with connector companies include initial preseries and sign-off of the connectors. // Regular follow-up and discussion with harnessing companies as delivery schedules of connector/cable become understood.	TBD	N/A
ITk Strip	Technical issue with modules	realised	6	Realised: a fraction of sensors on modules crack after thermal cycle. // Modifying module design (extra costs already incorporated).	N/A	N/A
ITk Strip	Failure of sensor cracking mitigations	5	12	Low risk given the preliminary results on interposer modules // Identify backup options for cracking and/or establish failure rate of modules on supports and accept.	TBD	TBD
ITk Strip	Stave core production rate issues	20	4	Validate stave production rate as early as possible in production. // Implementing Fraunhofer scenarios, could save up to 6 months.	25	450
ITk Strip	Production of services in industry is delayed	20	3	Frequent interactions with vendors. // Consider parallelising service module production a la Fraunhofer scenario (in fact, already starting to do this now).	10	100
ITk Strip	Module production rate issues	25	4	Design already simple and sites are qualified ahead of time. Preproduction and ramp up learning both help mitigate possibility // Fraunhofer scenarios investigated could gain up to 4 months of float by implementing multiple scenarios in tandem, total cost of scenarios is difficult to calculate. Some required more material, some required more resources.	100	500+
ITk Pixel	Additional iteration of FE chip	5	18	Mitigation no longer possible (in production) // An additional FE Chip design and submission.		900
ITk Pixel	Module pre-production issue leading to delay of the PRR or production time for module assembly longer than estimated	20	9	Run a detailed programme of production site qualification. // Options include more jigs and test system + increased effort (shifts), better infrastructure, rebalancing of production requirements. Only effective if applied to most sites in parallel.	400	9000
ITk Pixel	Commercial items not ready for surface integration	10	6	None possible. // Alternative vendor to be selected; new order and QC.	400	100
ITk Pixel	Delay in development of beam condition monitors, leading to delay of Inner System integration	20	6	Set up a production schedule of BCM' to match with the Inner System integration. Develop an integration sequence that allows BCM' installation at the end of Integration sequence. // If BCM's are late, it would need several months of 0.15 FTE technician.	N/A	100
ITk Pixel	Hybridization vendor(s) drop out or production rates slower than foreseen	35	6	Developing various vendor-sharing scenarios // Negotiating increased output from remaining vendors (if possible).	TBD	N/A
ITk Pixel	In-house production rates (other than module assembly) lower than foreseen	30	6	Qualifying procedures asap // Introducing shifts at mechanics and integration production sites (see Fraunhofer studies). Only effective if applied to most sites in parallel.	100	11000

Past Timeline



How did we get here?

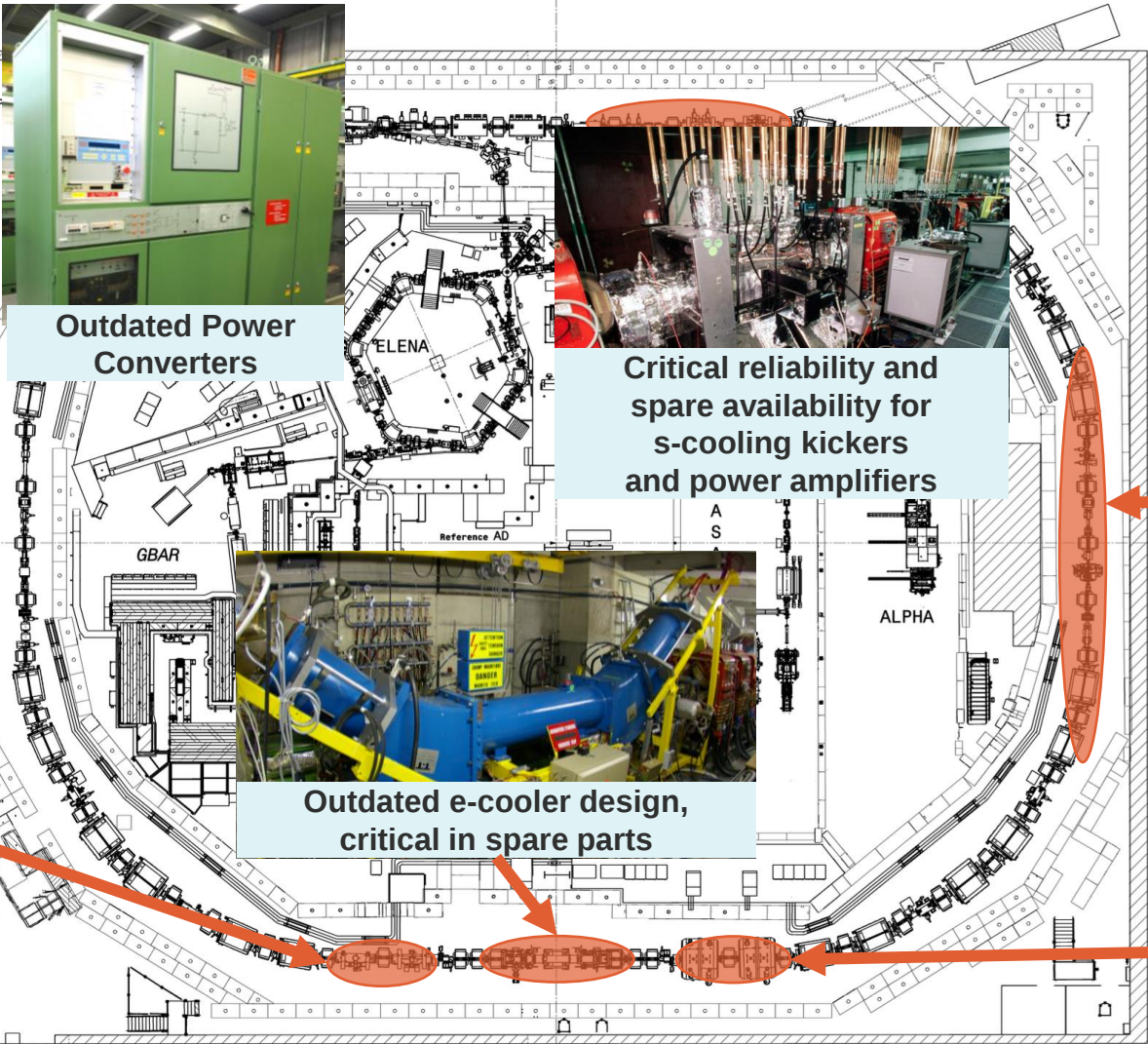
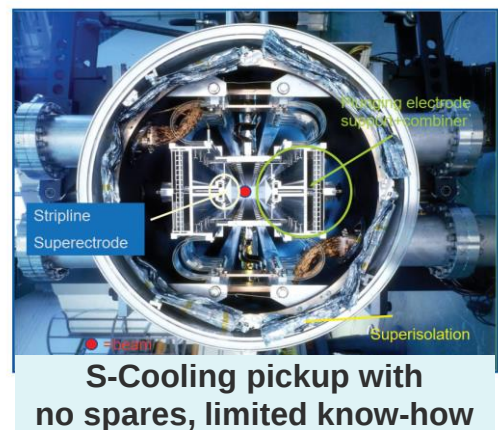
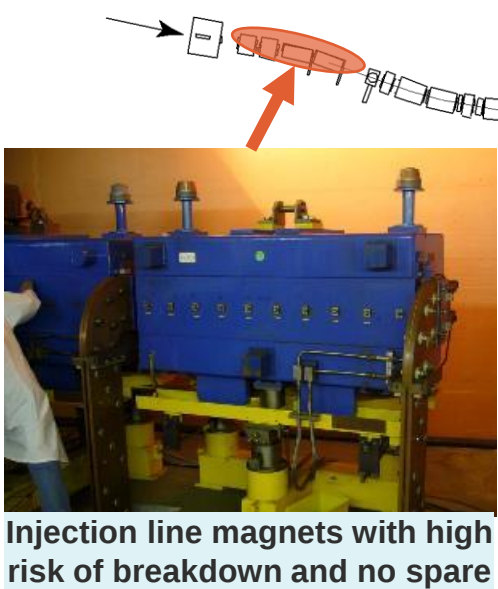
- **Modest investments** relative to CERN's capabilities
 - Leveraging on the possibility of **reusing existing hardware**
- **Exceptional commitment** from a handful of individuals, coupled with the **goodwill** of numerous others
 - **Not turn-key machines**: several **unique technologies/features!**
- **Resilient user community** conducting extensive, intricate, long, and unparalleled experiments on a **restricted budget** and with **scarce resources**
 - Over two decades of **specialized expertise** challenging to replicate
- Made possible by **CERN's** existing infrastructure and expertise

Might be impossible to replicate this anywhere else!

Current Facility Challenges: Infrastructure

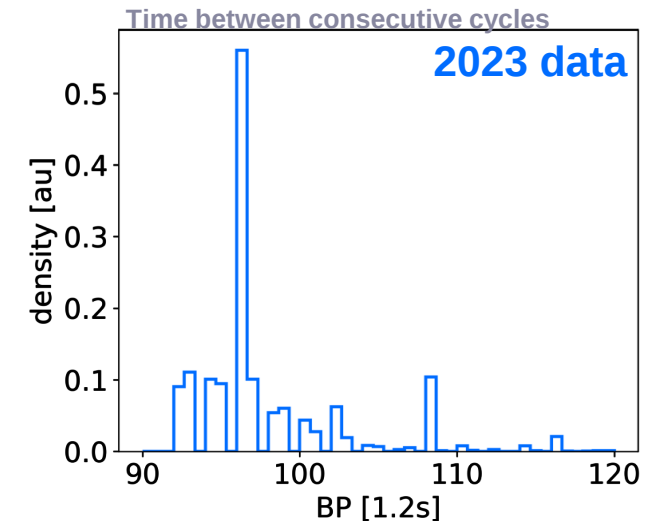
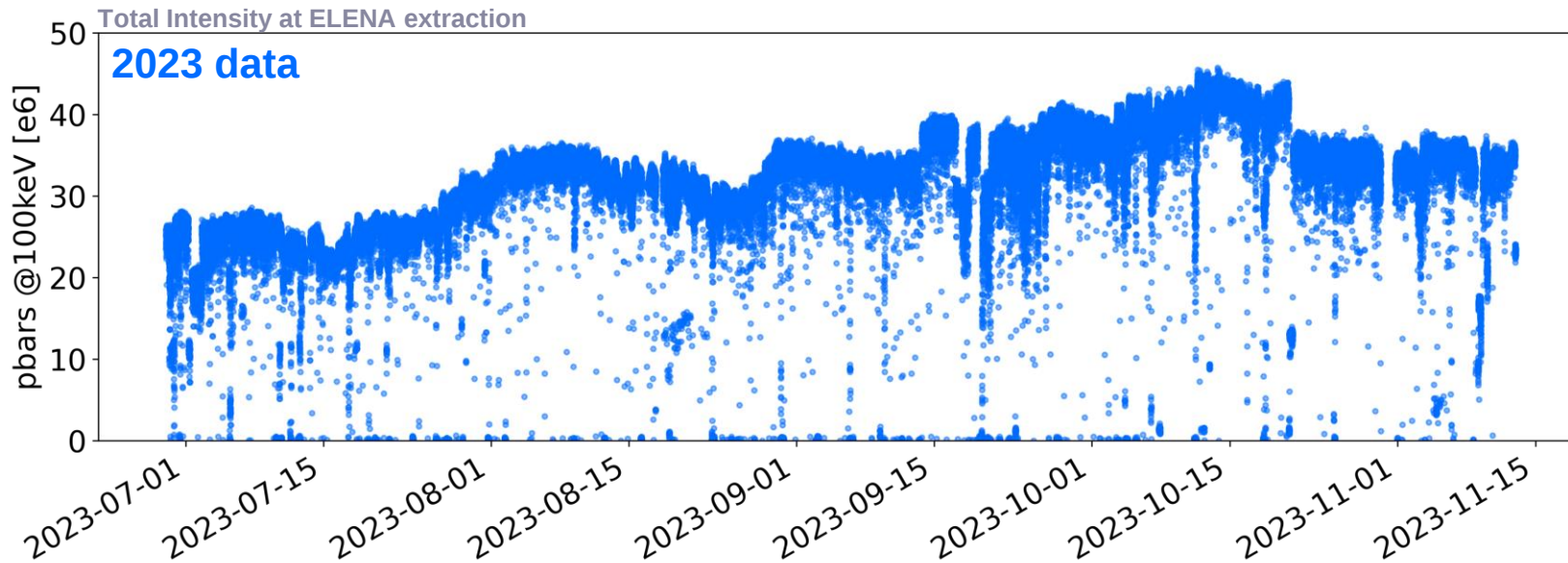
- **Hardware Aging, especially the AD!**
 - AD made from **hardware recycled from previous facilities**
 - *Example risk: water leak in special magnet in 2023* disrupted 10% of physics operation time
 - Ongoing **consolidation efforts** since the facility's early days
- **Liquid Helium Demand**
 - Our users are among the **top consumers** of liquid helium at CERN
 - Presently **running at maximum helium capacity**, and often not enough...
- **Space Constraints**
 - **AD hall** predominantly **occupied** by experimental setups
 - **Complex experiments** with **lengthy timelines** (>5 years) from setup to initial results
 - **Limited space** for **new/bigger experiments** and/or **auxiliary installation**,...

Hardware: Most Critical/Aged Items



Main user requirements: stability and reproducibility!

- Main request: stable intensity of more than 25e6 pbar every ~120 s (typically, higher flux is better)
 - Acceptable to have slow intensity drifts over time scales of days/weeks

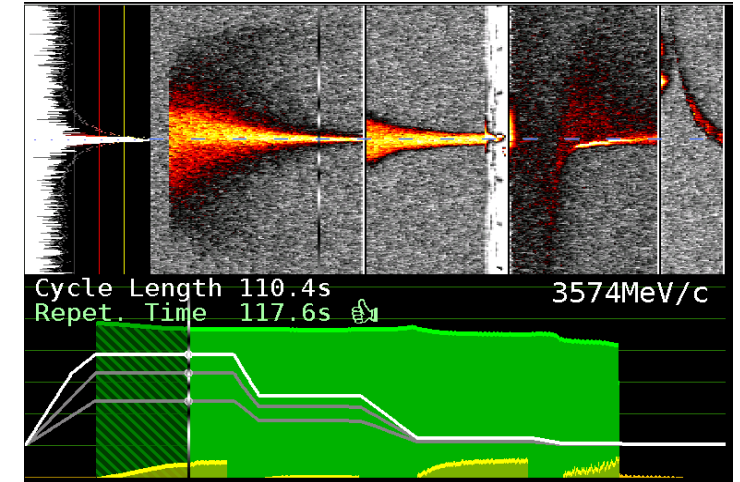


- In practice, quite some **intensity variation/fluctuation** (>20%!) over the year
 - Slow improvements thanks to motivated operation team
 - Slow/fast degradations due to natural drifts and hardware faults/issues
 - Shot-to-shot fluctuations due to non-reproducibility of several sub-systems
- Also, **repetition rate variation** driven by PS super-cycle composition and beam scheduling strategy
 - Not much we can do about it, but CERN-timing long-term plans to upgrade protons scheduling strategy

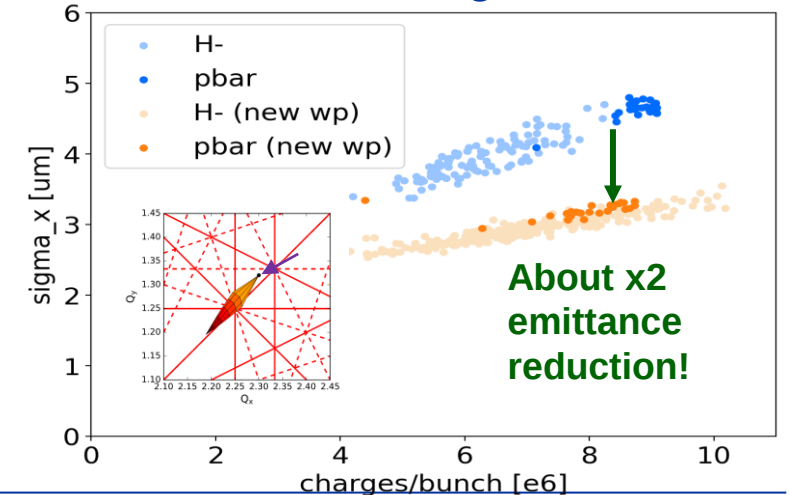
Current Facility Challenges: Beam Control

- **Challenges in Beam Diagnostics** in measuring very **low intensity** and **low energy** beams
 - **Mainly relying on Schottky and Intensity measurements**
 - i.e. indirect measurement of many possible faults/effects
 - **Only destructive transverse beam profile measurements**
- **Dedicated operation team :**
 - **Maintain high machine availability**
 - E.g. Finding solutions to run without BHZ-TRIM in 2022...
 - **Obtain the best performance from existing hardware**
 - E.g. toward ELENA design emittances, ...
 - **Respond to user needs**
 - E.g. Optimise beam transport from ELENA to traps ...
 - **Follow-up constant consolidation needs, often unique systems**
 - E.g. electron and stochastic cooling consolidations ...

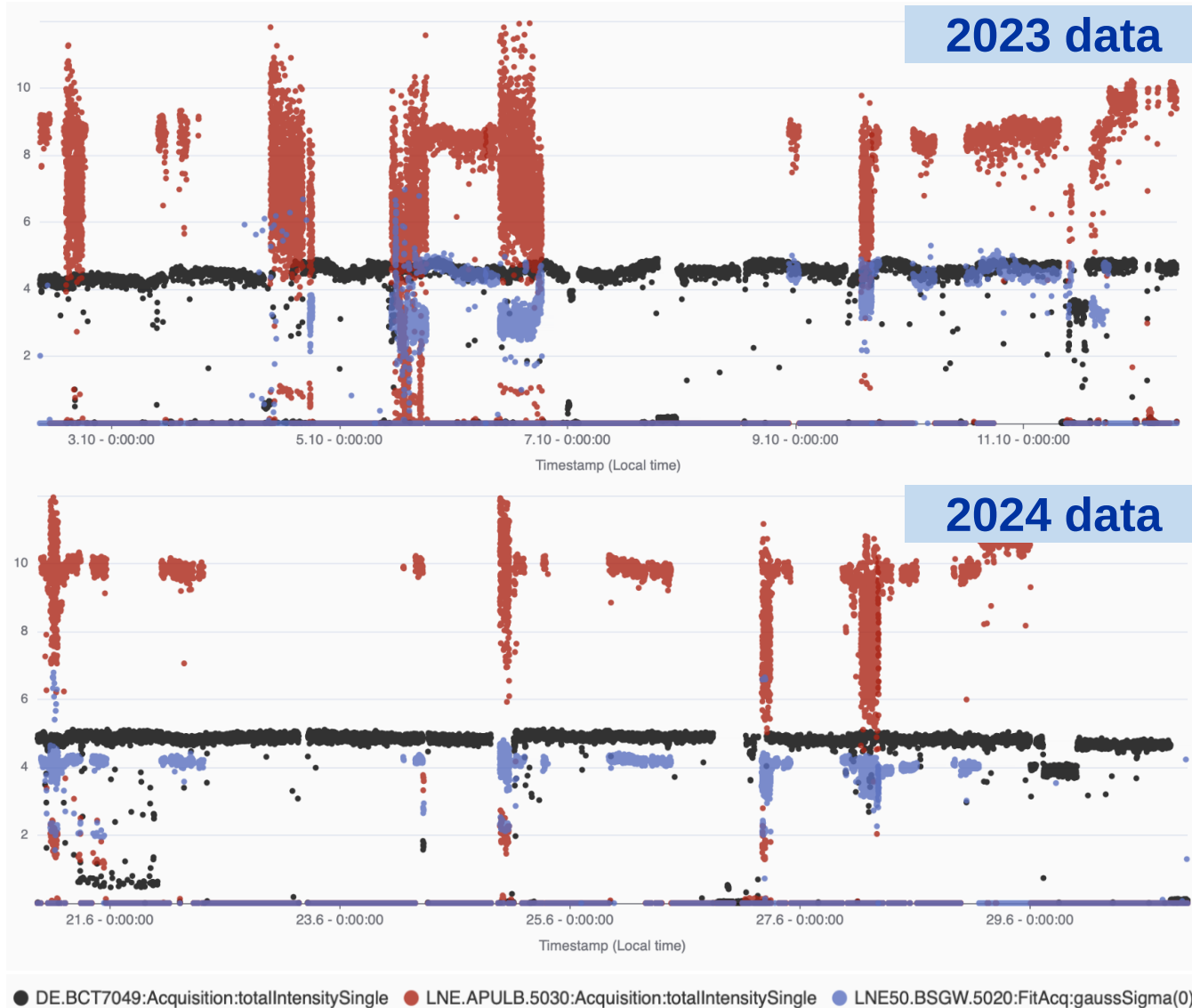
Schottky and Intensity (BCCCA) in AD



Toward ELENA design emittances!



Emittance Reduction in 2024: some Rough Plots



- Started 2024 physics run with new working point
 - Expected factor 2 smaller emittances
- Looking at about 10 days of operation (begin of Oct. 2023 vs end of Jun. 2024)
- Optimistically, beam size expected to scale as $\sqrt{1/2} = 0.7$ due to expected emittance reduction
- Beam size expected to increase ~linearly with intensity, i.e. going from $8.5e6$ to $10e6$, i.e. $10/8.5=1.2$
- $\Rightarrow 1.2 \cdot 0.7 = 0.84$ expected beam size variation
- $\Rightarrow$ from plots, observed $4/4.5 = 0.89$ beam size variation
- $\Rightarrow$ detailed analysis to be done, but more or less as expected

Antideuteron: tests we would like to do in AD

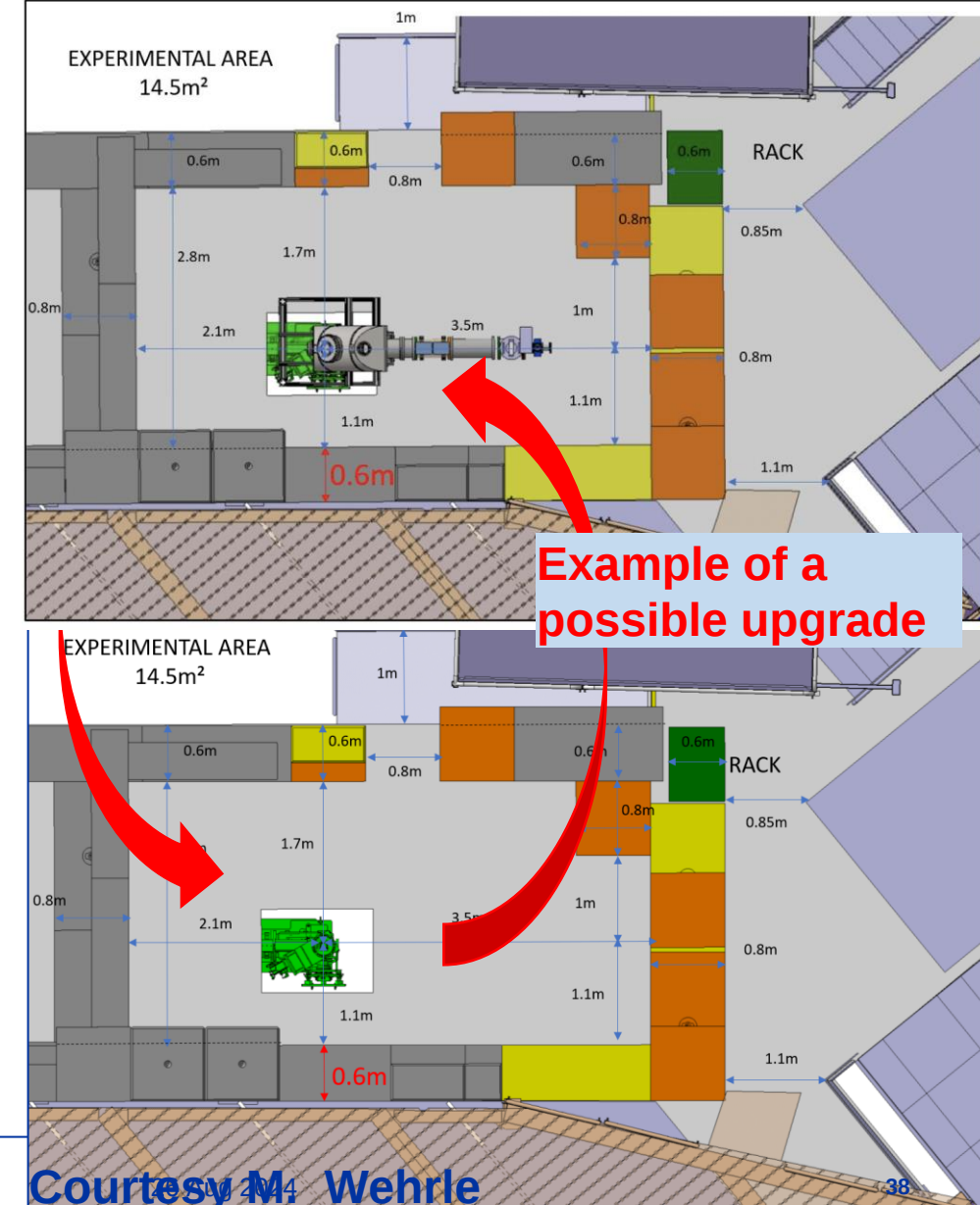
1. Check if we see something already now on Schottky at $f_{\text{rev}}=1.45509226$ MHz (instead of 1.589328 MHz of pbars)
 - **[done] – nothing seen**
2. Try to re-bunch at anti-deuteron frequency, start deceleration (to kill the pbars), then scrape the leftovers: do we “kill” something else, i.e. anti-deuteron??
 - **[partially done] - no signal visible.**
3. Try to configure s-cooling notch filter to cool (longitudinally) anti-deuteron
 - Maybe possible with old 2 GeV/c notch filter
4. Inject in AD at different (lower) momentum
 - **[done] – interesting results for pbars, but ring acceptance to be checked!**
5. Try to inject at $p=2.781$ GeV/c
 - This corresponds to C10 $h=7$ for anti-deuteron: maybe possible to see a coherent signal at injection?
 - **[done] – no dbars detected so far...**
6. ... Develop/install **resonant Schottky monitor** for single particle detection?
 1. Started to think about it in [AFMD-6](#)

Antideuteron: things will need to be changed

1. **If we need to look at higher momentum => requires a new ring... forget about it.**
2. **S-cooling system will need to be adapted for the new frequencies**
 - Likely need to change both pickup and kickers => a few MCHF project
3. **Bunch rotation system will need to be adapted**
 - Maybe possible to re-tune the cavities, but likely a several 100kCHF project
4. **Revolution frequency at the lowest AD momentum will be lower than today's FINEMET specs: need to investigate it...**
5. **Electron cooler will be able to cool at higher momentum, but to be checked for the 100 MeV/c plateau. The new e-cooler will possibly have similar performance....**
6. **Instrumentation will be likely blind to very low intensities**
 - Will probably need to setup most system with pbars, then switch to “feedforward” mode with no loops...
7. **Impact on ELENA to be studied....**
 - Bunch transfer to ELENA, RF system, instrumentation, e-cooling at very low voltages, ...

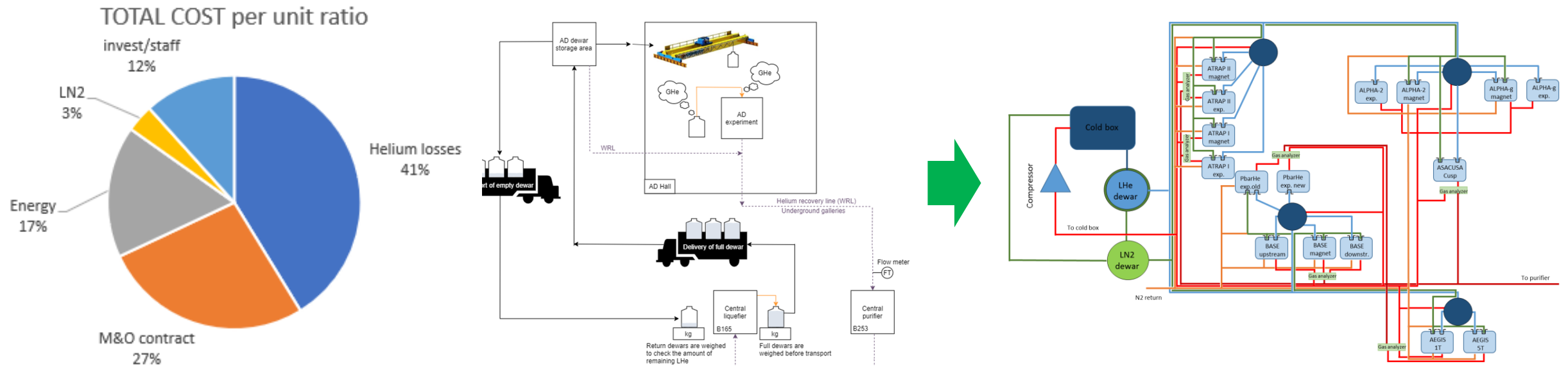
TELMAX: a new Test Area for new Ideas and Users

- Refurbishment of the old ATRAP2 area and conversion into a Test Line for Machine And eXperiments:
 - For accelerator equipment tests (e.g. instrumentation)
 - For **experimental equipment characterization** (e.g. foils, detectors R&D/calibration)
 - ...
- The area reorganized to increase usable surface :
 - Standard services will be provided (electricity plugs, demineralized water, compressed air, etc....)
 - Changes described in the ECR: **EDMS [2975107](#)**
 - **Normally available by end of 2024 !**
- **Beam-time request strategy being formalized**
 - will normally be regulated by “standard” **SPSC Beam Time Requests** as for other facilities
 - **Start expressing your interest now ! e.g. to [B. Holzer](#) or [F. Butin](#)**
- *PS: Possible to add standard CERN diagnostics in the future...*

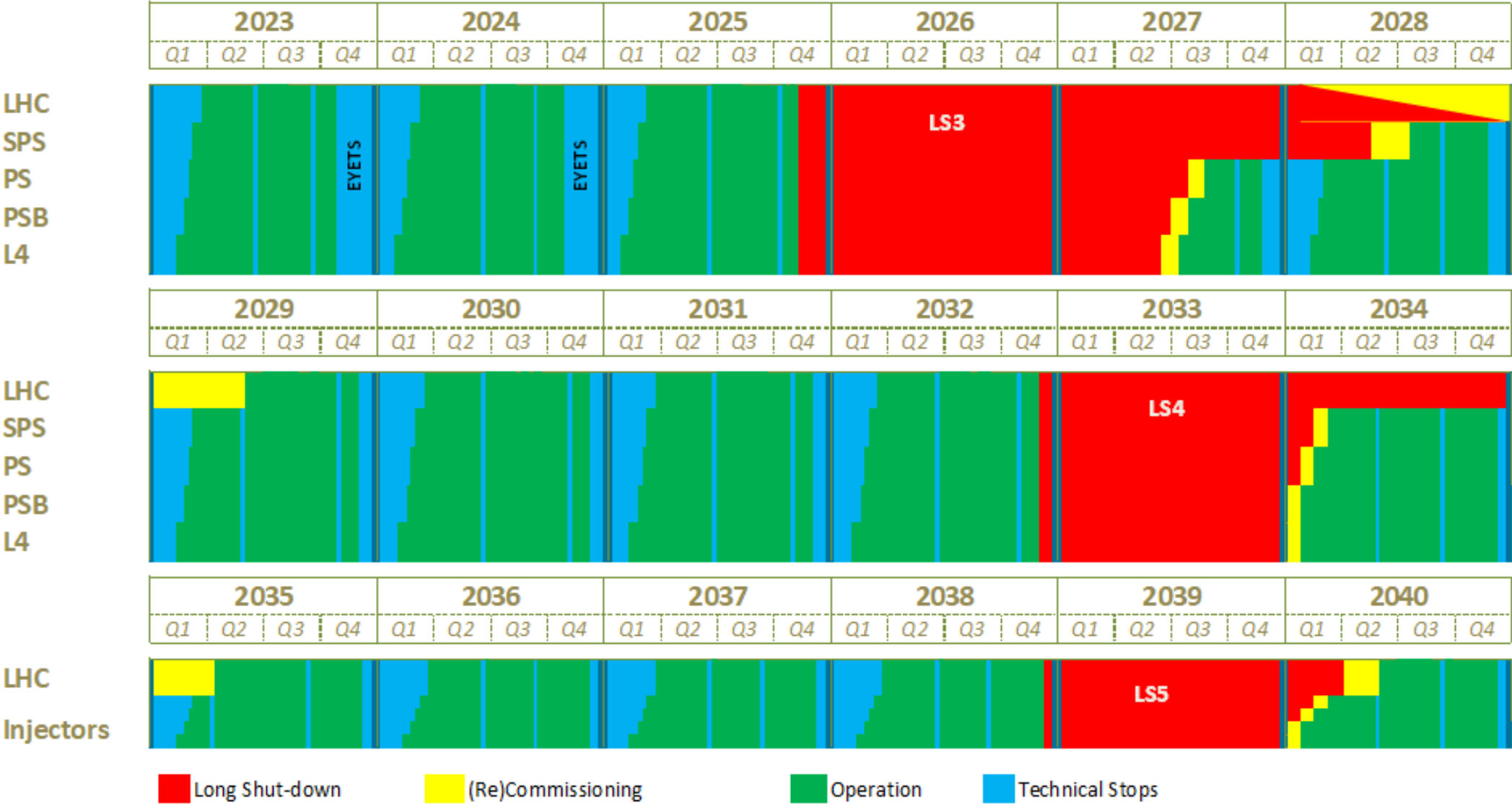


Users Helium Consumption

- CERN cost in 2022: ~2 MCHF for ~700x500L dewars of LHe
 - “Constantly” at 20 dewars/week delivery (CERN max capacity: 25 Dewars/week)
 - ~3140 m³/year of gHe (roughly 88 kCHF), mainly needed for pressurize Dewars for LHe transfer
- Alternative cooling methods, e.g. cryocoolers, will require long/costly RD program
- Closed circuit system with local liquefier:
 - Addresses distribution and safety concerns, offering a more eco-friendly solution!
 - Cost 8.3 MCHF + 8.5 FTE (only possible after LS3), savings 0.6 MCHF/year!



Long Term Schedule for CERN Accelerator complex



Timeline for the update of the European Strategy for Particle Physics



Proposed timeline for the European Strategy Update process

From official web page